S E D A R

Southeast Data, Assessment, and Review

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SEDAR 17
Data Workshop Report

South Atlantic Vermilion Snapper

July 2008

SEDAR is a Cooperative Initiative of:

The Caribbean Fishery Management Council
The Gulf of Mexico Fishery Management Council
The South Atlantic Fishery Management Council
NOAA Fisheries Southeast Regional Office
NOAA Fisheries Southeast Fisheries Science Center
The Atlantic States Marine Fisheries Commission
The Gulf States Marine Fisheries Commission

SEDAR Headquarters
The South Atlantic Fishery Management Council
4055 Faber Place #201
North Charleston, SC 29405
(843) 571-4366

Section II. Data Workshop Report

Contents

1. Introduction

1.1 Workshop Time and Place

The SEDAR 17 Data Workshop was held May 19-23, 2008, in Charleston, SC.

1.2 Terms of Reference

1. Characterize stock structure and develop a unit stock definition. Provide a map of species and stock distribution.

2. Tabulate available life history information (e.g., age, growth, natural mortality, reproductive characteristics, discard mortality rates); provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable. Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling.

3. Consider relevant fishery dependent and independent data sources to develop measures of population abundance. Document all programs used to develop indices; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics. Provide maps of survey coverage. Develop values by appropriate strata (e.g., age, size, area, and fishery); provide measures of precision. Evaluate the degree to which available indices represent fishery and population conditions. Recommend which data sources should be considered in assessment modeling.

4. Characterize commercial and recreational catch, including both landings and discard removals, in pounds and number. Discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector. Provide length and age distributions of the catch. Provide maps of fishery effort and harvest.

5. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Recommend sampling intensity by sector (fleet), area, and season.

6. Develop a spreadsheet of assessment model input data that incorporates the decisions and recommendations of the Data Workshop. Review and approve the contents of the input spreadsheet within 6 weeks prior to the Assessment Workshop.

7. Prepare complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report); prepare a list of tasks to be completed following the workshop, including deadlines and personnel assignments.

1.3 Participants

Appointee	Function	Affiliation
Coordination		
Dale Theiling	Chair and Chief Editor	SEDAR
Rachael Lindsay	Administrative Support	SEDAR
Data Management		
Rob Cheshire	Data Compiler	SEFSC
Commercial Statistics Workgroup		
Doug Vaughan	Leader and Editor	SEFSC
Kate Andrews	Data Provider and Rapporteur	SEFSC
Alan Bianchi	Data Provider	NC DMF
Steve Brown	Data Provider	FL FWC
Julie Califf	Data Provider	GA DNR
Jack Holland	Data Provider	NC DMF
Robert Wiggers	Data Provider	SC DNR
Geoff White	Data Provider	ACCSP
Dave Gloeckner	Data Provider	SEFSC/TIP
Kevin J. McCarthy	Data Provider	SEFSC/Logbooks
Recreational Statistics Workgroup		
Erik Williams	Leader, Rapporteur, and Editor	SEFSC
Doug Mumford	Data Provider	NC DMF
Robert Wiggers	Data Provider	SC DNR
Beverly Sauls	Data Provider	FL FWC
Tom Sminkey	Data Provider	MRFSS (MRIP)
Ken Brennan	Data Provider	SEFSC/Headboats
Life History Workgroup		
Jennifer Potts	Leader and Editor	SEFSC
Daniel Carr	Rapporteur	SEFSC
David Wyanski	Data Provider	SC DNR
Marcel Reichert	Data Provider	SC DNR
Doug DeVries	Data Provider	SEFSC
Chris Palmer	Data Provider	SEFSC
Stephanie McInerny	Data Provider	SEFSC
Indices Workgroup		
Kyle Shertzer	Leader and Editor	SEFSC
Helen Takade	Data Provider and Rapporteur	NC DMF
Rob Cheshire	Data Compiler	SEFSC
Elizabeth Wenner	Data Provider	SEAMAP
Pat Harris	Data Provider	MARMAP
Paul Conn	Data Provider	SEFSC
Geoff White	Data Provider	ACCSP
Kate Andrews	Data Provider	SEFSC

Analytical Team Representation

Kyle Shertzer	Vermilion Snapper Lead Analyst	SEFSC
Paul Conn	Spanish Mackerel Lead Analyst	SEFSC

Council Representation

Brian Chevront	Council Member	SAFMC
David Cupka	Council Member	SAFMC
Rick DeVictor	Vermilion Snapper Council Lead	SAFMC
Gregg Waugh	Spanish Mackerel Council Lead	SAFMC

Advisory Panel Representation

Ben Hartig	SAFMC AP Chair	FLA Commercial

Observers and Associates

Jeanne Boylan (SEAMAP)
Myra Brower (SAFMC)
Julie Defilippi (ACCSP)
Kim Iverson (SAFMC)
Bob Mahood (SAFMC)
Paulette Mikell (MARMAP)
Ernest Muhammad (SC DNR)
David Player (SC DNR)
Andi Stephens (SAFMC)
Jessica Stephen (MARMAP)
Elizabeth Vernon (SC DNR)

Acronyms
SEDAR 17 DW Attendance List

ACCSP	Atlantic Coastal Cooperative Statistics Program
AP	Advisory Panel
ASMFC	Atlantic States Marine Fisheries Commission
CCA	Coastal Conservation Association
CIE	Center for Independent Experts
FL FWC	Florida Fish and Wildlife Commission
FMP	Fishery Management Plan
GA DNR	Georgia Department of Natural Resources
MRFSS	Marine Recreational Fisheries Statistics System
MRIP	Marine Recreational Information Program
NC DMF	North Carolina Division of Marine Fisheries
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
SAFMC	South Atlantic Fishery Management Council
SEFSC	Southeast Fisheries Science Center, National Marine Fisheries Service
SC DNR	South Carolina Department of Natural Resources
SEDAR	Southeast Data, Assessment, and Review
SSC	Science & Statistics Committee, South Atlantic Fishery Management Council
TIP	Trip Interview Program, National Marine Fisheries Service

1.4 Workshop Documents

SEDAR 17
South Atlantic Vermilion Snapper and South Atlantic Spanish Mackerel
Data Workshop Document List

Document #	Title	Authors
Documents Prepared for the Data Workshop		
SEDAR17-DW01	South Atlantic Vermilion Snapper Management Information Worksheet	J. McGovern (SERO) R. DeVictor (SAFMC)
SEDAR17-DW02	South Atlantic Spanish Mackerel Management Information Worksheet	J. McGovern (SERO) R. DeVictor (SAFMC)
SEDAR17-DW03	South Atlantic Vermilion Snapper Assessment History	D. Vaughan (SEFSC)
SEDAR17-DW04	South Atlantic Spanish Mackerel Assessment History	D. Vaughan (SEFSC)
SEDAR17-DW05	South Atlantic Vermilion Snapper Commercial Chapter	D. Vaughan (SEFSC)
SEDAR17-DW06	South Atlantic Spanish Mackerel Commercial Chapter	D. Vaughan (SEFSC)
SEDAR17-DW07	A review of Spanish mackerel (*Scomberomorus maculatus)* age data, 1987-2007, Atlantic collections only, from the Panama City Laboratory, SEFSC, NOAA Fisheries Service	C. Palmer, D. DeVries, C. Fioramonti and L. Lombardi-Carlson (SEFSC)
SEDAR17-DW08	Vermilion Snapper Length Frequencies and Condition of Released Fish from At-Sea Headboat Observer Surveys in the South Atlantic, 2004 to 2007	B. Sauls, C. Wilson, D. Mumford, and K. Brennan (SEFSC)
SEDAR17-DW09	Development of Conversion Factors for Different Trap Types used by MARMAP since 1978.	P. Harris (MARMAP)
SEDAR17-DW10	Discards of Spanish Mackerel and Vermilion Snapper Calculated for Commercial Vessels with Federal Fishing Permits in the US South Atlantic	K. McCarthy (SEFSC)
SEDAR17-DW11	Standardized catch rates of vermilion snapper from the headboat sector: Sensitivity analysis of the 10-fish-per-angler bag limit	Sustainable Fisheries Branch (SEFSC)
SEDAR17-DW12	Estimation of Spanish mackerel and vermilion snapper bycatch in the shrimp trawl fishery in the South Atlantic (SA)	K. Andrews (SEFSC)
Documents Prepared for the Assessment Workshop		
SEDAR17-AW01	SEDAR 17 South Atlantic Vermilion Snapper Stock Assessment Model	To be prepared by SEDAR 17
SEDAR17-AW02	SEDAR 17 South Atlantic Spanish Mackerel Stock Assessment Model	To be prepared by SEDAR 17
Documents Prepared for the Review Workshop		

SEDAR17-RW01	SEDAR 17 South Atlantic Vermilion Snapper Document for Peer Review	To be prepared by SEDAR 17
SEDAR17-RW02	SEDAR 17 South Atlantic Spanish Mackerel Document for Peer Review	To be prepared by SEDAR 17
	Final Assessment Reports	
SEDAR17-AR01	Assessment of the Vermilion Snapper Stock in the US South Atlantic	To be prepared by SEDAR 17
SEDAR17-AR02	Assessment of the Spanish Mackerel Stock in the US South Atlantic	To be prepared by SEDAR 17
	Reference Documents	
SEDAR17-RD01	South Atlantic Vermilion Snapper Stock Assessment Report, SEDAR 2, 2003	SEDAR 2
SEDAR17-RD02	Update of the SEDAR 2 South Atlantic Vermilion Snapper Stock Assessment, 2007	SEDAR
SEDAR17-RD03	Fishery Management Plan for Spanish Mackerel, Atlantic States Marine Fisheries Commission, 1990	L. P. Mercer L. R. Phalen J. R. Maiolo
SEDAR17-RD04	Mitochondrial and nuclear DNA analysis of population subdivision among young-of-the-year Spanish mackerel (*Scomberomorus maculatus*) from the western Atlantic and Gulf of Mexico	V. P. Buonaccorsi E. Starkey J. E. Graves
SEDAR17-RD05	George Fishes MD TAFS 28 1-49	W. A. George
SEDAR17-RD06	Excerpt – Goode 1878 stats 7-1-99	Goode
SEDAR17-RD07	Excerpt – Henshall Comparative Excellence TAF 13 1-115	Henshall
SEDAR17-RD08	Stock Assessment Analyses on Spanish and King Mackerel Stocks, April 2003	Sustainable Fisheries Div, SEFSC
SEDAR17-RD09	Hooking Mortality of Reef Fishes in the Snapper-Grouper Commercial Fishery of the Southeastern United States	D.V. Guccione Jr.
SEDAR17-RD10	Effects of cryptic mortality and the hidden costs of using length limits in fishery management Lewis G Coggins Jr	L. G. Coggins Jr. and others
SEDAR17-RD11	Discard composition and release fate in the snapper and grouper commercial hook-and-line fishery in North Carolina, USA	P. J. Rudershausen and J. A. Buckel
SEDAR17-RD12	A multispecies approach to subsetting logbook data for purposes of estimating CPUE	A. Stephens and A. MacCall

SEDAR17-RD13	The 1960 Salt-Water Angling Survey, USFWS Circular 153	Clark, J. R.
SEDAR17-RD14	The 1965 Salt-Water Angling Survey, USFWS Resource Publication 67	Deuel, D. G. and J. R. Clark
SEDAR17-RD15	1970 Salt-Water Angling Survey, NMFS Current Fisheries Statistics Number 6200	Deuel, D. G.
SEDAR17-RD16	User's Guide: Delta-GLM function for the R Language /environment (Version 1.7.2, revised 07-06-2006)	Dick, E. J. SWFSC/NMFS
SEDAR17-RD17	Reproductive biology of Spanish mackerel, *Scomberomorus maculatus*, in the lower Chesapeake Bay. M.A. Thesis, Virginia Institute of Marine Science. (Selective pages)	Cooksey, C. L. 1996

SEDAR17 – South Atlantic Vermilion Snapper

II. Data Workshop Report

2. Life History

2.1. Overview – Members

Jennifer Potts – Group Leader
Daniel Carr
Chip Collier
Doug DeVries
Stephanie McInerny
Paulette Mikell
Chris Palmer
Marcel Reichert
Jessica Stephens
David Wyanski

2.2 Stock Definition and Description

Vermilion snapper have a broad geographic range extending from North Carolina to Sao Paulo, Brazil (Anderson, 2002). Although adult vermilion snapper have a relatively small home range based on mark recapture studies (Fable 1980), genetic studies have only found weak evidence for genetic stock structure in this species. This could be due to several factors including pelagic eggs mixing, insufficient time for genetic structure to be present, adults migrating among stocks, and hyper-variability of some genetic markers. The genetic reports range from no difference in the Gulf of Mexico (GOM) and US South Atlantic (SA) (Bagley et al. 1999) to minor differences among the two areas (Tringali and Higham, 2007). The weak genetic differences among the GOM and SA may be evidence of a strong barrier to connectivity among stocks (Tringali and Higham, 2007). Given the variability of the genetic studies, other indicators of stock structure were investigated.

Morphometric characteristics and life history traits are important components of stock assessments and can be used to detect the presence of different stocks (Swain et al. 2005). Mophometric characteristics include the weight-length relationship, fork length-total length relationship, and size-at-age. Life history traits include longevity, natural mortality, and maturity schedule. Both the morphometric characteristics and life history traits influence the predicted resiliency, growth, and recovery of a stock. Morphometrics and life history traits can be influenced by their environment and may vary from reef to reef. However, if there are significant differences among geographic regions, these traits should be considered in managing stocks.

Using the weight-length relationship for GOM vermilion snapper from SEDAR 9 Vermilion Snapper Data Workshop Report compared to the weight-length relationship for SA vermilion snapper, GOM vermilion snapper are predicted to be heavier than SA vermilion snapper for fish greater than 250 mm TL (10 inches).

Longevity estimates vary among the GOM and SA. GOM vermilion snapper reach a maximum age of 26 (SEDAR 9 Vermilion Snapper Data Workshop Report) and the SA vermilion snapper reach a maximum age of 19. This difference in maximum age may lead to differences in the natural mortality estimate if the estimate is based on Hoenig's (1983) natural mortality model.

Given the differences in the weight-length relationship, longevity, and weak genetic separation between the GOM and SA vermilion snapper, the Life History Work Group (LHWG) recommended keeping the GOM and SA management units separate for vermilion snapper. This is also consistent with SEDAR 15 for red snapper and greater amberjack. Additional studies should be undertaken to determine if phenotypic differences are persistent between the GOM and SA vermilion snapper stocks.

Recommendations for the AW:

1) Keep the SA and GOM as separate stocks and use the jurisdiction set by the SAFMC (i.e., North Carolina through the east coast of Florida including Monroe County south of US 1 out to 83^{o} West longitude).

2.3 Natural Mortality

Natural mortality is one of the hardest parameters of a stock assessment to determine. Many different estimators are available that rely on various age and theoretical growth parameters (Table 2.3.1). Due to the uncertainty and variability in the parameter estimates from the von Bertalanffy growth model, the LHWG recommend using the Hoenig estimator. Previous age and growth studies of vermilion snapper from the US South Atlantic found fish as old as 13 years. The current age and growth study found vermilion snapper as old as 19 years. The maximum age of the Gulf of Mexico stock was 26 years. The LHWG felt that the environment and fishing pressure are different enough between the two areas (GOM and SA) to expect differences in longevity and growth.

The LHWG felt that maximum age of 19 year old was reasonable for the SA stock, and the resulting Hoenig estimate of M was 0.22. For sensitivity analysis, the LHWG suggests a range of 0.16 – 0.28 to encompass estimates of M from the other methods of estimating M and from the Gulf of Mexico stock. The LHWG also presents the Lorenzen age based estimate of M using the von Bertalanffy parameters from all data combined, excluding the fishery-independent age 8+ fish and using the Diaz et al. correction methodology on the fishery-dependent data and age at the midpoint of the fishing year (Table 2.3.2).

Recommendations for the AW:

1) Model the natural mortality rate of vermilion snapper as a declining Lorenzen function of size.

2) The Lorenzen function should be scaled to an M of 0.22 - the Hoenig estimate of M based on a maximum age of 19 yr, with sensitivity runs between 0.16 and 0.28.

2.4 Discard Mortality

Since the last benchmark stock assessment on vermilion snapper in 2003, studies investigating release mortality on this species have increased. SEDAR 2 reported base estimates of 20 and 40 % release mortality for vermilion from recreational and commercial fisheries, respectively (SEDAR2_SAR2). These estimates were based on a 17 % release mortality reported during a venting study using fish released into cages (Collins et al. 1999) and 27 % mortality from unpublished data provided by Dixon and Huntsman (Dixon and Huntsman, unpub.) More recently, Guccione used a caging study to look at release mortality of several snapper/grouper species in the South Atlantic and reported 30 % mortality for vermilion snapper from a depth range of 34 to 55 meters (Guccione 2005). Caging studies can be useful for measuring delayed mortality for released species, but not predation. Burns et al. (2002) conducted a tag and recapture study to investigate mortality of various reef fishes from the Atlantic and Gulf of Mexico, however, only 6 of 825 vermilion were recaptured so there was not enough information available to calculate a release mortality estimate for this species.

Most release mortality estimates in recent years come from observing release condition of individual fish at the water's surface. Immediate mortality was calculated from both commercial and recreational fishing vessels. The At-Sea Headboat Observer Survey recorded release condition for 1,536 vermilion snapper caught by hook and line in east Florida from 2005 – 2007. Release mortality from this survey, 5.2 %, was the average percentage of dead discarded vermilion snapper across the 3 year study period. Discards were counted as "dead" if surface condition was recorded as poor, dead, or eaten (SEDAR17-DW08). The Commercial Logbook Program reported immediate release mortality rates for vermilion snapper for 5 regions between Florida and North Carolina (regions 1 -5) by randomly sampling commercial logbooks from 20 % of the currently fishing commercial vessels in the South Atlantic. Region 5 (North Carolina) had a release mortality rate of about 70 % which was uncharacteristically high compared to the other 4 regions. A release mortality of 20 % was calculated by averaging mortality rates from all regions (SEDAR17-DW10). Harris and Stephen (2004) looked at immediate mortality rates of vermilion snapper by accompanying one commercial fisherman for about 5 months. Data from this study can not estimate delayed mortality but it does include fish that were not immediately released by the fisherman. This estimate was 50 % mortality. Estimates of release mortality that include deck time are higher than other estimates observing immediate release condition. Also observed and recorded by Harris and Stephen (2004) were vermilion that were not released but kept as bait. Keeping vermilion as bait is not currently documented as a common practice of the commercial fishery, though the Snapper Grouper logbooks do have a category for fish "kept but not sold". The "kept" fish may be used for bait. The estimates of the number of fish "kept" cannot be used to characterize release mortality for the entire fishery. Instead, they need to be treated separately, but at the time of the data workshop, it was not decided how that should be handled.

The most recently published study on release mortality for snappers and groupers from the commercial fishery estimated immediate and delayed mortality rates. Immediate mortality for vermilion snapper was estimated to be 8.9 % (Rudershausen et al. 2007). This was calculated from discards observed by Rudershausen et al. (2007) from 2004 – 2006 along with additional discards recorded during another study currently in progress (Pers. Comm., Paul Rudershausen). Vermilion snapper used to estimate immediate mortality were captured between 29 – 57 meters. Delayed mortality estimates were calculated using a Monte Carlo simulation model that incorporated the percentage of observed gastric distention by depth as well as hooking mortality rates by body location. Hooking mortality rates were compiled from several previously published studies on various reef fish species. Delayed mortality for vermilion snapper caught from 25 – 75 meters was determined to be 38 %. This was the average delayed mortality from two depth ranges, 25 – 50 meters and 50 – 75 meters.

<u>Recommendations for the AW:</u>

1) The delayed mortality estimate from Rudershausen et al. (2007) of 38 % will be recommended as the base release mortality for both commercial and recreational fisheries. The discarded fish not counted as landings, but kept for some other reason need to be treated separately from the other discards. To be determined at the Assessment Workshop.

2) Sensitivity ranges of 20 – 50 % will be recommended as well, which were based on an average of the probability density distributions around the delayed mortality rate at each depth range, 25 – 50 and 50 – 75 meters.

2.5 Age

2.5.1. Aging procedures and error matrix

SEDAR 2 recommended that SCDNR and at the NOAA Beaufort Lab collaborate in providing an aging-error matrix for use in age- and length-structured assessment models. In 2008 the SCDNR and NOAA Beaufort laboratories held an ageing workshop and discussed methods and interpretation of otolith structures. The conclusion of this workshop was that both labs used the same methods (otoliths are aged sectioned) and interpret the otolith structures in similar ways. After the workshop otoliths of 583 vermilion snapper were read by both labs and the results compared. Each lab provided two readers and precision was calculated using average percent error (APE; Beamish and Fournier, 1981). Sixty percent of age readings were in agreement, and 95% were within ± 1 year. Average percent reader error (APE) was 8.32%. Production aging laboratories generally consider an APE ≤5% as a target for moderately long-lived species with relatively difficult to read otoliths (Morison et al., 1998; Campana, 2001). Amongst personnel aging vermilion snapper from the Gulf of Mexico, APE has been reported as high as 8.4% (Allman et al., 2001). Typically most of the disagreement between readers is due to difficulty establishing the first or core ring, which seems to be a common problem for many reef fish (Fowler 1995). Opaque zones near the core often make distinguishing the first annulus difficult. In the case of vermilion snapper, there was no bias in age reading for one lab or another (i.e., one lab did not consistently age the fish one more year than another lab). Aging error matrices are available in Table 2.5.1.1 based on the 583 samples read by both laboratories.

Recommendations for the AW:

1) NMFS Beaufort Lab and SCDNR personnel assigned ages to fish in a consistent manner and thus age data sets can be combined.

2) Aging error matrices can be used in the assessment model.

2.5.2. Availability and treatment of age data

The LH WG recommended using calendar age (not increment count) in the analyses. For all fish collected from January through August the age was the number of increments (count) +1 if the otolith had a wide translucent edge. In all other samples the age was equal to the number of increments (count).

Complete age data for fishery-independent (MARMAP) collections were available from 2002 through 2007. In 2000 and 2001, only part of the collected otolith samples were read, and from 1995 through 1999, no valid age readings are available. Prior to 1995 age readings are available, but samples were selected to construct an age/length key and not all samples were read.

Age data from fishery-dependent sources were collected since 1975. The earliest samples through 1991 were from the headboat fishery. Samples were from commercial and headboat fisheries from 1992 – 2002, and since then other recreational fishery samples from the east coast of Florida have been added to the collection (Table 2.5.2.1).

Recommendations for the AW:

1) The LH WG recommended for the fishery-independent source that only samples from 2002 through 2007 be used for age composition analysis.
2) All fishery-dependent age data can be used in the age composition analysis.
3) For comparison of size-at-age data, the LH WG recommends using the 2002-2007 fishing years due to the issues with the fishery-independent data and the most comprehensive fishery-dependent data is available.

4) The LH WG recommend using all data available to determine the von Bertalanffy growth parameters.

2.5.3. Variability in size at age

The size-at-age data for the 2002-2007 fishing years are presented as the median sizes (Figure 2.5.3.1; errors are plus/minus 1 quartile), due to the non-normal distribution of the length at each age of the fishery-dependent data because of the minimum size regulations. Overall, size-at-age in vermilion snapper is highly variable (Figure 2.5.3.2). Further analysis, separating sexes, and preliminary cohort analysis indicated that this high variability is real and a robust phenomenon. These findings are consistent with those reported by Allman et al. 2001 for vermilion snapper data from the Gulf of Mexico. The high variability in the size-at-age means that almost all age classes are subject to selection, because of legal limits. This selection may be a reason for the non-normality of the size-at-age data.

2.5.4. Differences in size at age between sexes

There were differences in size-at-age between males and females in some age classes (MARMAP 2007, data 2002-2007). However there is a large overlap due to the high variability in the size-at-age data in both males and females. The LH WG recommended sexes be combined in the size-at-age analysis. This recommendation was based on the inconsistency in the differences between age classes, the high variability in the data, and the fact that sex is not determined in fishery-dependent collections.

<u>Recommendations for the AW:</u>

All data should be combined for the assessment regardless of the sex.

2.5.5. Regional differences in size at age

Preliminary analysis indicated possible regional differences in size-at-age between NC-SC and samples collected further south (south of 31° latitude). Further investigations showed that the differences in size-at-age were only present in the recreational catches (Figure 2.5.5.1). The LH WG speculated that possible differences in fishing depths between regions may be a reason. Analysis of size-at-depth using the fishery-independent data showed some indications of an increase in size with depth, but the gear selection (small number of larger fish) and the high variability in the data prevent conclusive conclusions.

<u>Recommendations for the AW:</u>

The LH WG determined that the size-at-age data do not support the need for regional stock assessments.

2.6 Growth

Determining the theoretical growth of vermilion snapper has been difficult. The large variability in size-at-age, gear selectivity, location of catch and minimum size limit regulations have all influenced the von Bertalanffy growth parameters. There were also differences in size-at-age between fishery dependent (NMFS Beaufort) and fishery independent (MARMAP) data sets. These differences resulted in different von Bertalanffy growth parameters. The LF WG concluded that the fishery-independent data better represented the lower age classes, although the number of fish smaller than 250mm TL in the complete data set. Furthermore, the fishery-dependent data set included more larger, older fish. This may indicate that the MARMAP data set is subject to a gear selection in the larger size classes as seen in Figure 2.5.3.2, especially in age 8 and older. The LH WG recommended using a dome shape selectivity curve for the MARMAP data. The LH WG also recommended using the combined data sets of all years to characterize the growth of the vermilion snapper population in the SA (Table 2.6.1; Figure 2.6.1). To address the known effect of legal size limits for both the recreational catches (279 mm TL) and the commercial catches (305 mm TL) in the analysis of the von Bertalanffy parameters, the LH WG recommended to use the Diaz correction (Diaz et al. 2004) for the fishery-dependent data.

<u>Recommendations for the AW:</u>

All age data is to be used to estimate the von Bertalanffy growth model parameters. The Diaz et al. (2004) correction methodology will be applied to the fishery-dependent data affected by the minimum size regulations.

2.7 Reproduction

2.7.1 Spawning season

The spawning season of vermilion snapper is from April through September, peaking in June, July, and August (Cuellar et al. 1996, Mikell et al, 2008). Males appear to be reproductively active sooner and longer than the females.

2.7.2 Fecundity

There are no recent fecundity estimates available and the LH WG recommends using the data from Cuellar et al. (1996). The reported spawning periodicity for vermilion snapper off the southeastern United States is once every 5 to 5.5 days or 27 to 35 times per season (Cuellar et al. 1996, Mikell et al, 2008). The batch fecundity (BF or number of hydrated oocytes) is strongly related to fish length and is given by: $BF=0.0438*(\text{fork length in mm})^{2.508}$ (Cuellar et al. 1996). In comparison, Hood and Johnson(1999) reported that BF for the Gulf of Mexico vermilion snapper population was positively related to fish weight by: $BF=317*(\text{whole weight in gram})-3.162*10^4$.

Recommendations for the AW:

Annual fecundity should be used in the assessment model and is in the range of 27*BF to 35*BF.

2.7.3 Maturity schedules

Reproductive information for vermilion snapper is restricted to MARMAP data (reproductive data available through 2005). Only six of the 5,800 individuals collected between 1988 and 2005 and examined for reproductive stage were immature. These individuals ranged from 167 to 224 mm fork length. Almost all 1 year old males and females in the MARMAP data-set (1988-2005) are mature. These data are consistent with data from the Gulf of Mexico vermilion snapper where mature gonads were found in 69% of females at age 0, 84% at age 1, and 100% at all older ages (Hood and Johnson 1999).

The small number of immature fish prevented estimates of length and age at 50% maturity. Since no new data are available, the LF WG recommends using the maturity schedules based on what was provided for SEDAR2 (SEDAR2 2003, figure 5) for the current stock assessment: 0% at age-0, 80% at age-1, and 100% at age-2+.

Recommendations for the AW:

The maturity schedule for vermilion snapper is 0% at age-0, 80% at age-1, and 100% at age-2+.

2.7.4 Sex Ratio

The annual sex ratio data came from MARMAP data for years 1977 through 2006. The proportion of females in the data collected from 1977- 1987 was relatively constant around 62%. The proportion of females in the stock appeared to increase in 1988 and then hold relatively constant around 72% (Figure 2.7.4.1). It is difficult to determine whether this apparent shift in the proportion of females in the population is a real phenomenon or a result of gear selectivity. The MARMAP fishery-independent survey made a change in gear from a combination of trawls, “Antillean” traps, blackfish traps, fly nets and hook and line from 1977 – 1987 to chevron traps and hook and line since 1988.

Recommendations for the AW:

The LHWG recommends using the proportion from the 1988-2006 data, 72%, where the gear used by the MARMAP Survey was the most consistent.

2.8 Meristics and Conversion Factors

Several meristic conversion equations were generated for this assessment from fishery-dependent and fishery-independent data sources. The fishery-dependent sources included the Headboat Survey data and Florida's FWRI recreational fishery survey. The fishery-independent data came from MARMAP Survey. Total length – fork length linear conversion was based on 28,799 fish (Table 2.8.1a). The power function for whole weight – total length was based on 28,777 fish (Table 2.8.1b). Finally, the whole weight – gutted weight no intercept equation was based on 51 fish collected from Onslow Bay, NC (Table 2.8.1c).

<u>Recommendations for the AW:</u>

See Table 2.8.1

2.9 Life History Research Recommendations

As in previous assessments of reef fish in the US South Atlantic, studies on potential migration and stock structure of vermilion snapper between the Gulf of Mexico and SA need to be undertaken.

Estimates of mortality of fish are always difficult to quantify. Release mortality of undersized fish and fish exceeding the bag limit or trip limit should be easier to measure than natural mortality rates. More studies on release mortality are required and must include parameters such as disposition of the fish when released and time spent on deck before release. The level of use of undersized vermilion snapper as bait needs to be quantified and added as landings or some form of discard mortality, separate from the released fish.

Age and growth data need to be continually collected. The recreational component of the fishery is still not adequately sampled in the entire region, specifically north of Florida. We need the information to help determine area differences in age structure and growth. We also need sex specific data included with all biological samples. The MARMAP group needs to go back through their collections and fill in missing year's data as well as data for samples not selected for age-length keys prior to 1994. There needs to be a through investigation of how many age samples are enough for an assessment based on year, location, fishery and gear.

Further investigation into selectivity of gear and minimum size limit regulation impacts to the biological samples collected is required. Possible alternatives to the von Bertalanffy growth model need to be investigated, as well as the Diaz et al. methodology to correct for non-normal distribution of age samples due to size limits. More smaller fish, <200 mm TL, are needed to derive a better fit of the growth model at the youngest ages. Those fish are also needed for reproductive biology studies, as well as fish caught in the commercial and recreational fisheries.

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2.11 Tables

Table 2.3.1 Vermilion snapper natural mortality rates.
M: Natural mortality, k: VonBertalanffy growth parameter, T: temperature (°C), L_{inf}: Von Bertalanffy asymptotic length (mm), t_{max}: Maximum age, a_m: age at 50% maturity. FD: Fishery-Dependent data, FI: Fishery-Independent data. Maximum age = 19; Bottom water temperature = 25.09 °C; Age at 50% maturity = 1.

Data Source	L_∞ (mm)	k	Alverson & Carney	Hoenig	Pauly	Ralston	Jensen	Rule of thumb
All Years FD and FI data, FI ages 8+ excluded, t_0 unbound	**506**	**0.12**	**0.26**	**0.22**	**0.37**	**0.27**	**0.18**	**0.16**
2002-2007 FD and FI data, t_0 unbound	479.1	0.163	0.22	0.22	0.45	0.35	0.24	0.16
2002-2007 FD and FI data, t_0 = -1.00	413.6	0.291	0.12	0.22	0.69	0.62	0.44	0.16
2002-2007 FD data only, t_0 unbound,	454.4	0.225	0.17	0.22	0.57	0.48	0.34	0.16
2002-2007 FD data only, t_0 = -1.00	455.4	0.220	0.17	0.22	0.56	0.47	0.33	0.16
All Years FD data only, t_0 unbound,	550.6	0.131	0.25	0.22	0.38	0.29	0.20	0.16
All Years, FD data only, t_0 = -1.00	467.9	0.212	0.18	0.22	0.54	0.46	0.32	0.16
2002-2007 FI data only, t_0 unbound,	363.8	0.241	0.15	0.22	0.63	0.52	0.36	0.16
2002-2007 FI data only, t_0 = -1.00	333.7	0.465	0.05	0.22	1.00	0.98	0.70	0.16
All Years FI data only, t_0 unbound,	319.4	0.419	0.06	0.22	0.94	0.88	0.63	0.16
All Years, FI data only, t_0 = -1.00	312.4	0.567	0.03	0.22	1.16	1.19	0.85	0.16

Table 2.3.2 Vermilion snapper age specific natural mortality (Lorenzen) using the von Bertalanffy parameters from all years combined, excluding fishery-independent age 8+ fish with t_0 unbound, age at the midpoint of the fishing year, and scaled to M=0.22. Upper and Lower M are the 90% confidence intervals around the unscaled M.

Age	TL (mm)	W (grams)	M	Upper M	Lower M	Scaled M
0.5	192.9	92.4	0.93	1.40	0.58	0.36
1.5	228.3	150.8	0.80	1.24	0.49	0.31
2.5	259.7	219.3	0.71	1.12	0.43	0.28
3.5	287.6	294.9	0.65	1.04	0.39	0.26
4.5	312.3	374.8	0.61	0.98	0.35	0.24
5.5	334.2	456.4	0.57	0.93	0.33	0.22
6.5	353.6	537.9	0.54	0.89	0.31	0.21
7.5	370.8	617.7	0.52	0.86	0.30	0.20
8.5	386.1	694.7	0.50	0.84	0.29	0.20
9.5	399.7	768.0	0.49	0.81	0.28	0.19
10.5	411.7	837.1	0.47	0.80	0.27	0.19
11.5	422.4	901.7	0.46	0.78	0.26	0.18
12.5	431.8	961.7	0.45	0.77	0.25	0.18
13.5	440.2	1017.0	0.45	0.76	0.25	0.17
14.5	447.6	1067.8	0.44	0.75	0.25	0.17
15.5	454.2	1114.2	0.43	0.74	0.24	0.17
16.5	460.1	1156.4	0.43	0.73	0.24	0.17
17.5	465.3	1194.8	0.43	0.73	0.24	0.17
18.5	469.9	1229.5	0.42	0.72	0.23	0.17
19.5	474.0	1260.8	0.42	0.72	0.23	0.16

Table 2.5.1.1 Error matrix age readings of 583 vermilion snapper. Sectioned otoliths were read by SC-DNR (Marcel Reichert and Paulette Mikell) and a consensus reading was done on all otoliths that yielded differences in readings. NMSF Beaufort readers were Jennifer Potts and Stephanie McInerny and readings were analyzed separately (comparison SC v. NC, or combined and averaged (comparison NC v. SC).

SC-DNR (consensus reading)				
NS-Steph.	avg	sd	CV	n
0				
1	2.50	2.121	85%	2
2	2.42	0.827	34%	97
3	3.18	0.685	22%	220
4	3.89	0.687	18%	135
5	4.67	0.750	16%	78
6	5.61	0.567	10%	28
7	6.56	0.512	8%	16
8	6.00	0.000	0%	1
9	8.00	0.000	0%	3
10	8.67	0.577	7%	3
11				

SC-DNR (consensus reading)				
NS-Jen.	avg	sd	CV	n
0				
1	1.83	0.753	41%	6
2	2.39	0.626	26%	120
3	3.25	0.629	19%	195
4	3.99	0.643	16%	139
5	4.88	0.743	15%	77
6	5.73	0.944	16%	30
7	6.33	0.707	11%	9
8	6.50	2.121	33%	2
9	8.25	0.500	6%	4
10				
11	9.00	0.000	0%	1

SC age consensus	NC combined			
	avg	sd	CV	n
0				
1	1.92	0.669	35%	6
2	2.20	0.467	21%	86
3	3.04	0.640	21%	200
4	3.78	0.768	20%	160
5	4.59	0.948	21%	80
6	5.78	0.726	13%	36
7	6.72	0.461	7%	9
8	9.00	0.535	6%	4
9	10.00	0.816	8%	2
10				
11				

Table 2.5.2.1 Fishery-dependent vermilion snapper age samples available for the stock assessment by year, state and fishery. CB = Charter Boat; CM = Commercial; HB = Headboat; PR = Private Boat; RC = Recreational unknown type.

	Florida					Georgia		North Carolina			South Carolina	
Year	**CB**	**CM**	**HB**	**PR**	**RC**	**CM**	**HB**	**CB**	**CM**	**HB**	**CM**	**HB**
1975												1
1980			11									1
1981			112									
1982			38									
1983			2									
1986			89									
1987			7							1		
1988			2									
1991			10							136		20
1992		9								41	36	5
1993		74	1						94	42		5
1994		120	1						20	116	24	135
1995		263	117			3			50	50	1	24
1996			56							6		11
1997		55	6							7		1
1998		104	2									
1999		136										
2000		209										
2001	84	244	22									
2002	217	181	10									
2003	360	74	67	7				34	48	29		7
2004	102	159	299						353	29		3
2005	302	59	329	3	1				466	155	209	2
2006	230		487	2			8		461	51	484	51
2007	31	40	490				5		496	173	486	53
Total	1326	1727	2158	12	1	3	13	34	1988	836	1240	319

Table 2.6.1 Vermilion snapper von Bertalanffy growth parameters from combined data sources using the Diaz et al. (2004) correction methodology on the fishery-dependent data to account for size selectivity of fish due to minimum size regulations.

Fishery-Dependent and Fishery-Independent data

Years	t_0	L_∞	K	t_0
All years, FI ages 8+ excluded	**unbound**	**506**	**0.12**	**-3.5**
2002-2007	t_0 unbound	479.1	0.163	-2.43
2002-2007	bound	413.6	0.291	-1.00

Fishery-Dependent data only

Years	t_0	L_∞	K	t_0
2002-2007	t_0 unbound	454.4	0.225	-0.98
2002-2007	bound	455.4	0.22	-1.00
All Years	t_0 unbound	550.6	0.131	-2.14
All Years	bound	467.9	0.212	-1.00

Fishery-Independent data only

Years	t_0	L_∞	K	t_0
2002-2007	t_0 unbound	363.8	0.241	-3.00
2002-2007	bound	333.7	0.465	-1.00
All Years	t_0 unbound	319.4	0.419	-1.74
All Years	bound	312.4	0.567	-1.00

Table 2.8.1 Vermilion snapper conversion equations for (a) length-length linear regression, (b) weight-length power function, and (c) whole weight-gutted weight no-intercept regression. TL = total length in mm; FL = fork length in mm; SL = standard length in mm; WW = whole weight in g; GW = gutted weight in g.

a.

Data Source	Dep. Var.	Ind. Var.	a	b	r^2	n	Dep. Var. Range	Ind. var. Range	Units
SA Headboat, State of FL recreational, and MARMAP fishery-independent	TL	FL	1.436	1.106	0.994	28,799	100-615	91-546	mm
	FL	TL	0.371	0.898	0.994	28,799	91-546	100-615	mm
	TL	SL	5.02	1.273	0.994	15,900	100-615	79-476	mm

b.

Data Source	Dep. Var.	Ind. Var.	a	b	r^2	n	Length Range	Weight Range	Units
SA Headboat, State of FL recreational, and MARMAP fishery-independent	WW	FL	2.5×10^{-5}	2.927	0.97	31,359	91-503	12-2,300	mm, g
	WW	TL	2.1×10^{-5}	2.907	0.96	28,777	100-560	12-2,300	mm, g

c.

Source	Equation	Units	n	r^2	slope	SE	Min WW	Max WW
Fishery-Independent collection	WW = slope*GW; no intercept	kg	51	0.998	1.068	0.006	0.15	2.10

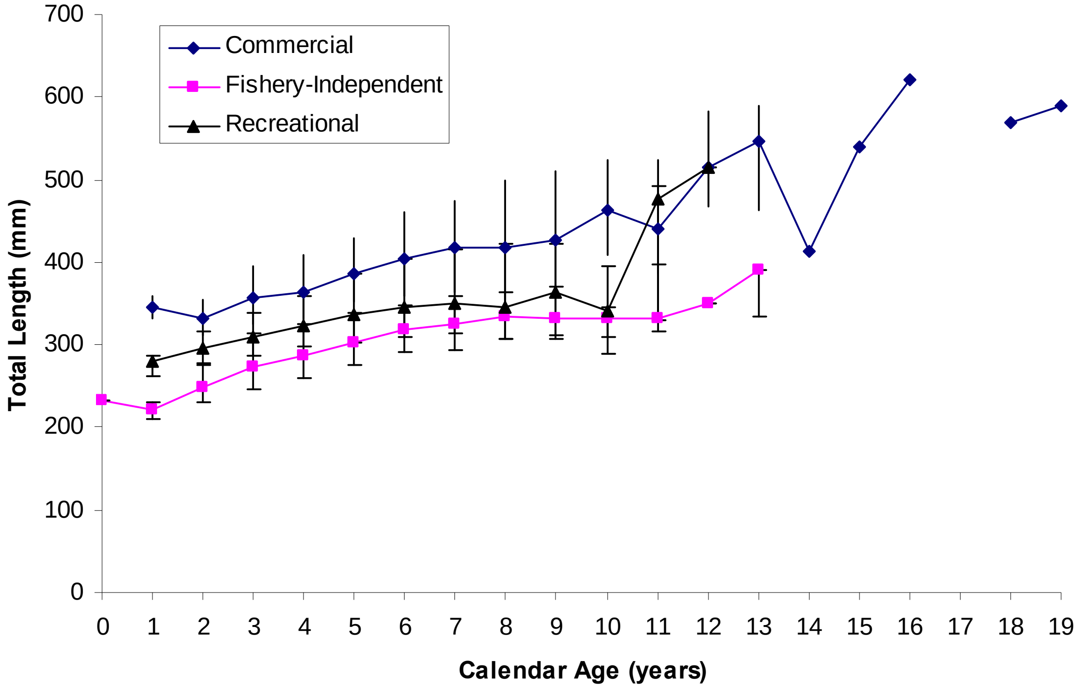

Figure 2.5.3.1 Vermilion Snapper 2002-2007 median size-at-age (errors are ± 1 quartile), for the US South Atlantic combined.

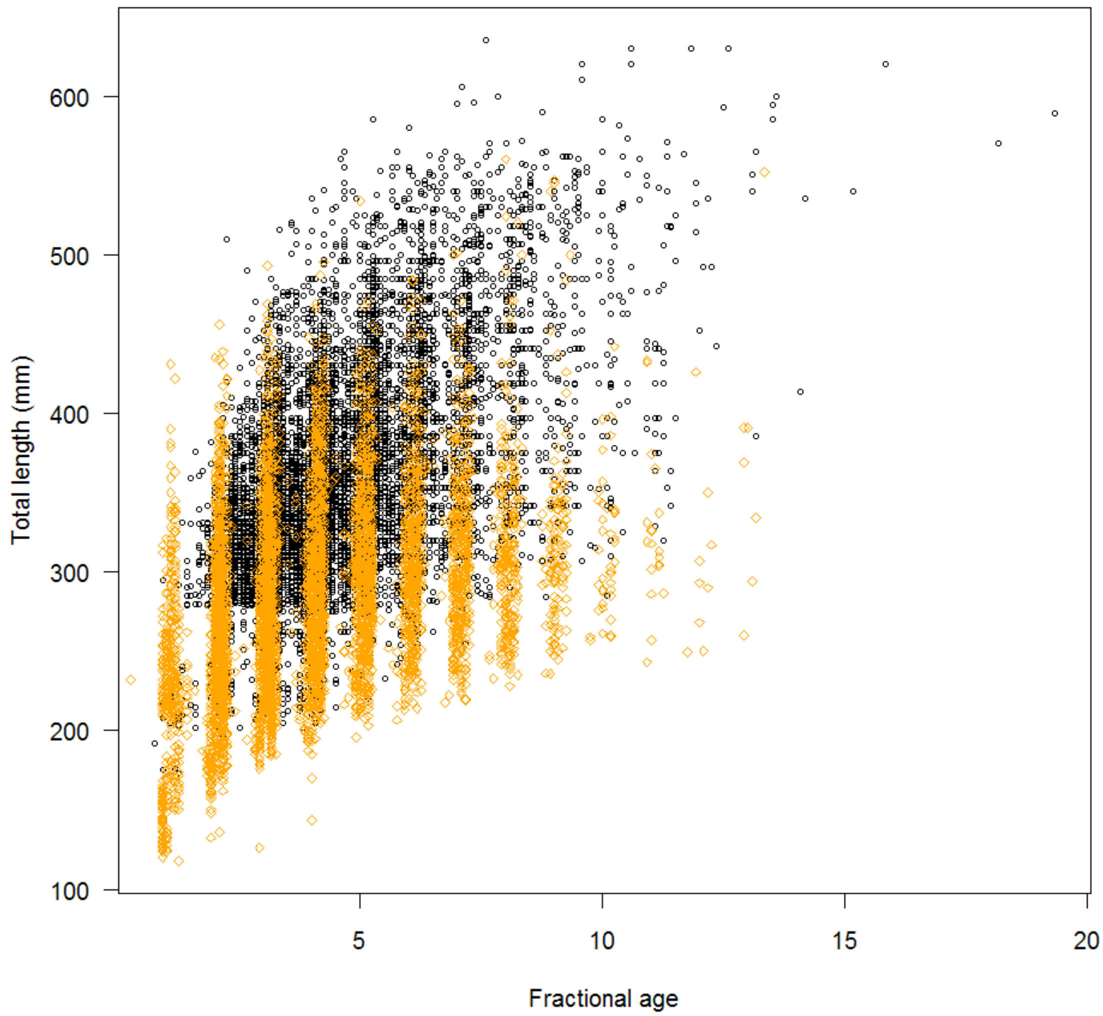

Figure 2.5.3.2 Vermilion snapper 2002-2007 size-at-age data for the US South Atlantic: Fishery-dependent v. fishery-independent.

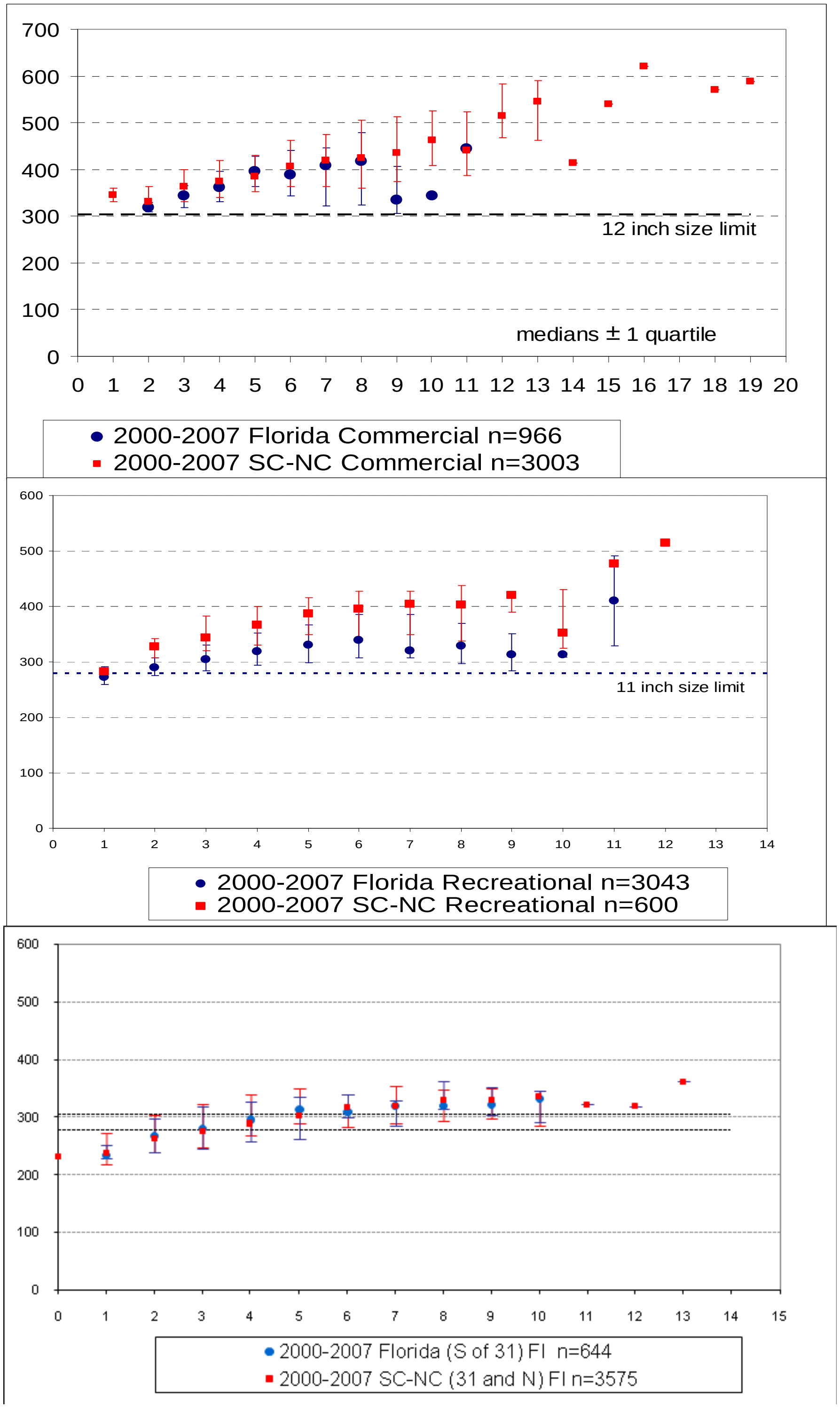

Figure 2.5.5.1 Median size (mm TL, y-axes) at age (year, x-axes) for vermilion snapper for NC/SC and Florida data. Data from 2000 through 2007. Error bars are ± 1 quartile. Horizontal dashed lines indicate the legal size limits (12 inches for commercial and 11 inches for recreational catches).

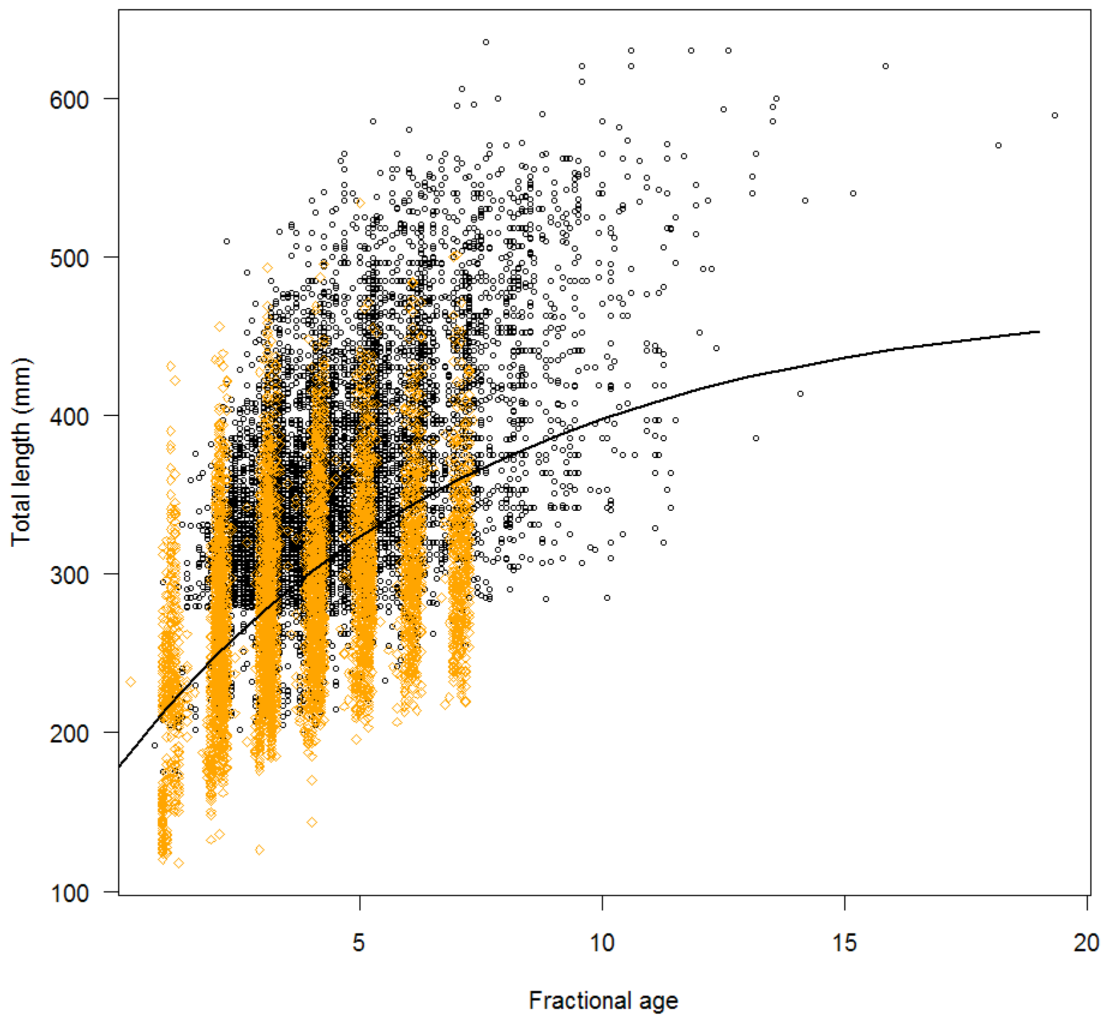

Figure 2.6.1 Vermilion snapper size-at-age data based on fractional age and the von Bertalanffy growth curve fit to the data. Data for age-8+ from the fishery-independent data has been eliminated due to dome selectivity of the MARMAP trap gear.

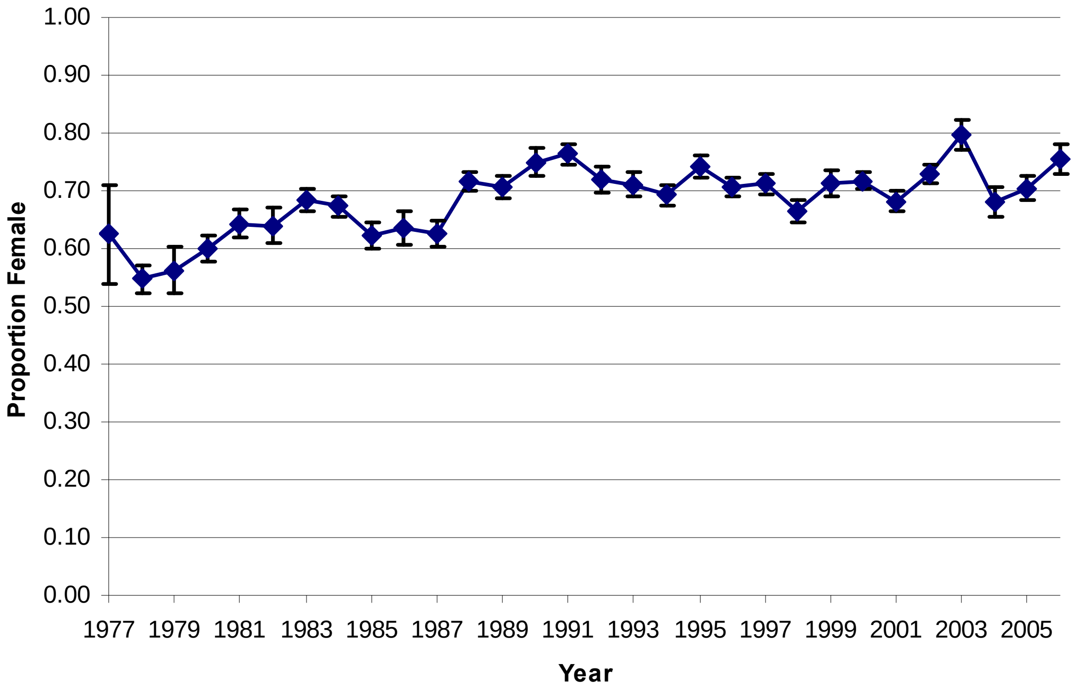

Figure 2.7.4.1 Proportion of female vermilion snapper in the US South Atlantic population.

3 Commercial Fishery

Chair: Douglas Vaughan (NMFS Beaufort); Rapporteur: Kate Andrews (NMFS Panama City); Members: Alan Bianchi (NC DMF), Jack Holland (NC DMF), Robert Wiggers (SC DNR), Julie Califf (GA DNR), Steve Brown (FL FWI), Dave Gloeckner (NMFS Beaufort), Kevin McCarthy (NMFS Miami), and Ben Hartig (FL Commercial Fisherman).

3.1 Overview

Historical commercial landings data for vermilion snapper were explored to address several issues. These issues included: (1) geographic stock boundaries, (2) historical perspective of landings data, (3) gear groupings for pooling landings, (4) mis-identification of species or need to expand unclassified snapper landings, (5) final presentation of landings by gear in pounds (whole weight) and in numbers based on state and federal data, (6) estimates of discards in numbers from commercial logbooks, (7) length and age compositions sampled from commercial fisheries, and (8) research needs.

3.2 Commercial Landings

3.2.1 NMFS Website and SAFIS for Commercial Landings

Initially, the NMFS website for commercial landings:

http://www.st.nmfs.noaa.gov/st1/commercial/landings/annual_landings.html

was queried on 12 March 2008 for all vermilion snapper landings along the Atlantic coast by state from 1950-2007. This query produced annual landings (available by gear) from 1958-2006 for Florida (east coast), Georgia, South Carolina, and North Carolina.

Additionally, we queried the Standard Atlantic Fisheries Information System (SAFIS, Internet based data entry system developed by the ACCSP) for commercial landings of vermilion snapper for Virginia and north. Only 75 pounds were reported as landed by bottom otter trawl from New York in 2005, otherwise no landings were available from Virginia and north that were identified as vermilion snapper. During the DW plenary, the need to query data bases for vermilion snapper landings north of the Virginia-North Carolina line for future assessments was emphasized.

Decision 1. Because essentially no vermilion snapper landings were reported north of North Carolina, the Workgroup recommended using the VA/NC line as the northern boundary for the South Atlantic vermilion snapper stock.

The NMFS website for commercial landings splits Florida into Florida East Coast (Atlantic) and Florida West Coast (Gulf of Mexico). Subsequent data bases post stratify

Monroe County (including the Keys) into Atlantic and Gulf of Mexico stocks. More detail is provided below.

The NMFS website contained landings back to 1950 for most species. Because the query showed no results for 1950-1957, the presumption is that none exist on this database. Other historical documents do not show commercial landings for vermilion snapper in the South Atlantic prior to 1958. Also, there were only small amounts of “snapper” (unclassified) on the NMFS website during the 1950s.

Decision 2. Because vermilion snapper landings were small prior to the 1970s, the Workgroup concluded that it was unnecessary to extend vermilion snapper landings prior to 1958 (earliest positive landings available), and therefore recommends that estimates of commercial landings be extended back to 1958.

These landings data were summarized by commercial gear, for initial exploration of which gears may be most important for landing vermilion snapper. Based on these data for 1958-2006, various line gears (handlines) accounted for 82.8% of the landings, combined gears for 12.0%, and otter trawls for another 4.5%. Miscellaneous gears made up the remainder (mostly pots & traps). This issue was further investigated with the SEFSC ALS database described next.

3.2.2 **Accumulated Landings System (ALS)**

Historical commercial landings (1962 to present) for the US South Atlantic are maintained as the Accumulated Landings System (ALS) in Miami by the SEFSC. For detailed description of the Accumulated Landing System (ALS), see addendum to this section. These data were made available by Josh Bennett (NMFS Miami). These data permit some refinement in setting the boundary for landings (catches) from Monroe County into South Atlantic and Gulf of Mexico stocks. We used the same approach as in SEDAR 15 for red snapper and greater amberjack. All Florida landings with water body codes 0010, 0019, and 7xxx were considered South Atlantic vermilion snapper regardless of Florida state code (10, 11, or 12). Also included were the undefined water-bodies (0000 and 9999) from ALS state 10 (Atlantic). See maps showing shrimp statistical areas for the Gulf of Mexico and U.S. Atlantic coasts (Figure 3.1) and Florida statistical areas (Figure 3.2).

Decision 3. The Workgroup decided to divide vermilion snapper into South Atlantic and Gulf of Mexico stocks by using the same approach as for the recent greater amberjack and red snapper assessments (SEDAR 15).

The ALS data were obtained from two databases. The primary database contains landings for all southern states by month and gear for 1962-2007. However, Florida data for the period 1977-1996 contains no gear information (gear is reported as code 999). To obtain gear-specific information for Florida for 1977-1996, one must refer to the other database (aka Florida General Canvass), which contains no corresponding monthly information (month = 13). The proportion of landings by gear from the Florida general canvass data base was applied to the unknown (gear = 999) landings from the primary data base to develop gear-specific landings from Florida for the period 1977-1996.

These data were summarized by gear code to assess the importance of different gears to the vermilion landings. Commercial landings for vermilion snapper were mostly from handlines (almost 98% by weight) based on the historical ALS data (1962-2007) for Atlantic Florida. Similarly, handlines were the dominant fishing gear for commercial landings from Georgia – North Carolina, accounting for over 93% by weight. However, there were historically important landings from trawls, or almost 6% of the commercial landings by weight from Georgia – North Carolina. These trawl landings were particularly important during the late 1970s and early 1980s (and were banned by Snapper-Grouper Amendment 1 in 1989, although trawl landings persist, perhaps as bycatch from other trawl fisheries).

Decision 4. The Workgroup recommended that landings by fishing gear be reduced to two categories, the dominant handline gear and historically important trawl gear. The small percentage from miscellaneous 'other' gears can be pooled with handlines.

The Workgroup was in general agreement with the SEDAR 2 Commercial Workgroup that mis-identification of vermilion snapper is minimal, and that, for instance, red snapper reported as vermilion snapper is unlikely. Also, mis-identification of vermilion snapper as red snapper was also thought to be minimal (after SEDAR 15 Commercial Workgroup).

Decision 5. The Workgroup concluded that mis-identification of vermilion snapper as another snapper or vice-versa was not a significant issue, and no corrections were necessary.

Vermilion snapper landings are variably recorded to species and as unclassified snappers. Reporting to species is more prevalent in recent years, and the proportion of total snapper landings reported as unclassified declines over time. After much discussion, the Workgroup agreed with the decision of the SEDAR 2 Commercial Workgroup. That is, unclassified snappers in Atlantic Florida were not though to include vermilion snappers. Unclassified snappers from Georgia were minimal (about 9000 lb in 1977 and 1978, otherwise generally less than 100 lb) and not thought to include vermilion snappers. However, unclassified snappers from South Carolina and North Carolina were thought to include vermilion snappers and were proportioned out as follows. Total vermillion landings are estimated for each state by year and gear reported to species (including vermilion snapper, but not red snapper). In general, the proportion of vermillion landings relative to the total snapper landings reported by species is used as a multiplier to estimate the proportion of vermillion landings in the unclassified category. For years in which there are no landings reported by species, the time series average percent vermillion is used to estimate the portion of vermillion snapper in the unclassified category. Further discussion relative to South and North Carolina will be found in section 3.2.3 under those state headings.

Decision 6. The Workgroup agreed that no treatment of unclassified snappers was required for Florida and Georgia, but was needed for South Carolina and North Carolina.

Vermilion snapper are typically landed in gutted form. The Workgroup agreed that to reduce confusion in reported landings between recreational and commercial fisheries, commercial landings should be reported in whole weight. Because vermilion snappers landings are originally obtained in gutted weight, and the conversion factors from gutted to whole weight vary by state, it was decided that the state landings would be transformed back to their original gutted weight, and then a single, biologically-based conversion factor would be applied to convert back to whole weight. In addition, a table is provided summarizing commercial landings by gear in gutted weight (pounds).

Decision 7. To reduce possible confusion with presentation of recreational landings, the Commercial Workgroup decided to present commercial landings as whole weight.

3.2.3 Commercial Landings Developed from State Databases

Commercial landings in whole weight were developed based on classified Vermilion snapper by the Working Group from each state by gear for 1958-2007.

Florida – Edited data from 1986-2007 were extracted and summarized by year, coast, area fished, county landed, and gear with whole pounds, gutted pounds, and number of trips from the Florida trip ticket database. Gears selected for summary were lines (rod & reel, long line, and electric reel combined), trawl, and other. Other gear consisted mostly of unclassified, dive and other net gears. Number of trips with other gear is noticeable from 1986-1992 because gear was not required on the trip ticket until late 1991. To fill in for missing gears for those years, we assigned gear to trips based on gears listed on the commercial fishers' annual license application. A hierarchy of these gear types, based on usage in later years, was used in combination with species composition on the trips to assign the most appropriate gear. Landings were then separated into Monroe county and Florida south Atlantic landings by year and gear.

Vermilion snapper data from NOAA Fisheries logbooks were extracted and summarized by year, state, coast, county and gear with gutted pounds, whole pounds, and number of trips. Gears were categorized as either as described above, as with trip tickets. Florida landings were separated into Florida Atlantic counties and Monroe county, and the proportion of Atlantic landings was calculated for Monroe county by year and gear. In addition, since logbook data did not start until 1990, and 1992 was selected as the first complete year, an annual average proportion of landings by gear from 1992-2007 was calculated to apply a proportion to pre-1992 data in the trip ticket landings.

The proportions calculated by year and gear for Atlantic landings from Monroe county were then applied to the Florida trip ticket landings from Monroe county by year and gear. Similarly, the annual average proportion from logbooks calculated from 1992-2007 was then applied to Monroe county Florida south Atlantic landings to each year, by gear, from 1986-1991. The proportioned landings for Monroe county were then added to the landings from the Atlantic counties by year and gear for final Florida SA landings by gear from 1986-2007.

<u>Georgia</u> – We are confident there is no misidentification of vermilion snapper by Georgia dealers and our dockside sampling has demonstrated that vermilion snapper are not sorted as unclassified snapper. As such, no adjustments were made to the data. Landings were provided for 1989 – 2007.

<u>South Carolina</u> – South Carolina commercial landings data were reported by coastal dealers starting in 1972 through mandatory monthly landings reports required from all SC licensed wholesale dealers. These reports were summaries which collected species, pounds landed, market category, catch disposition (gutted or whole), ex-vessel price and area fished. In September 2003, South Carolina began collecting trip level information through mandatory trip tickets, which captures detailed effort information along with fisherman and vessel identifiers. Commercial landings for vermilion snapper are reported in gutted pounds and separated by market category. Weights associated with each market category are combined to arrive at a cumulative total, and landings are converted to whole pounds using a conversion factor of 0.9 (e.g. divide gutted weight by 0.9). Canvas data are stored and extrapolated from an MS Access database for all landings, by species, by gear, back to 1972. In addition to vermilion snapper, landings that were reported as unclassified snapper (which were first reported as such in 1976) were also separated out by calendar year and gear (hand line, trawl, other) to determine the proportion of that catch estimated to be vermilion snapper. To arrive at a proportion, classified snapper landings (e.g. vermilion, silk, cubera, mango, mutton, yellowtail, dog, blackfin, and lane), excluding red snapper (since it was deemed in SEDAR 15 that red snapper were consistently reported as such), were combined into a total classified category by calendar year and gear type. Vermilion snapper landings (also separated by gear and year) were then divided by the total classified landings to determine the proportion of vermilion in the classified snapper landings. The proportion for each year, for each gear type, was then multiplied by the respective landing weights reported in the unclassified snapper category to estimate the weight of vermilion reported as unclassified snapper. The resulting weight was then added to the annual vermilion snapper landings in each respective gear and year category. South Carolina vermilion snappers landings are compared with and without including a portion of unclassified snappers (Figure 3.3).

<u>North Carolina</u> – The National Marine Fisheries Service prior to 1978 collected commercial landings data for North Carolina. Port agents would conduct monthly surveys of the state's major commercial seafood dealers to determine the commercial landings for the state. Starting in 1978, the North Carolina Division of Marine Fisheries entered into a cooperative program with the National Marine Fisheries Service to maintain the monthly surveys of North Carolina's major commercial seafood dealers and to obtain data from more dealers. The North Carolina Division of Marine Fisheries Trip Ticket Program (NCTTP) began on 1 January 1994. The NCTTP was initiated due to a decrease in cooperation in reporting under the voluntary NMFS/North Carolina Cooperative Statistics Program in place prior to 1994, as well as an increase in demand for complete and accurate trip-level commercial harvest statistics by fisheries managers. The detailed data obtained through the NCTTP allows for the calculation of effort (i.e. trips, licenses, participants, vessels) in a given fishery that was not available prior to 1994 and provides a much more detailed record of North Carolina's seafood harvest.

Annual landings of vermilion snapper were calculated for the SEDAR 17 Data Workshop for North Carolina. The annual landings cover the years from 1958 to 2007 to be consistent with other South Atlantic States, although North Carolina has no landings of vermilion snapper prior to 1971. Data used to calculate the landings for North Carolina include the North Carolina Trip Ticket Program (1994 to 2007), landings from the ALS (1962 to 1993), and landings from historical data (prior to 1961). Extrapolations of vermilion snapper from the unclassified landings of snapper were made from data prior 1993. All data collected from the North Carolina Trip Ticket Program was not changed or extrapolated. To calculate the amount of vermilion snapper in unclassified snapper landings, the proportion of vermilion snapper to other identified snappers was calculated from 1978 to 1991 by gear type. This calculation excluded landings of red snapper because it was assumed all red snapper were identified correctly and this logic is consistent with SEDAR 15. The calculated proportion was then applied to all unclassified landings of snapper to calculate a new adjusted landings total for vermilion snapper by gear type. North Carolina vermilion snappers landings are compared with and without including a portion of unclassified snappers (Figure 3.4).

Combined Landings in Weight – Annual landings in whole weight provided by the states were augmented with ALS landings back to 1962 as needed for years not covered by state landings. Landings prior to 1962 (1958-1961) were those downloaded from the NMFS website. Because individual states applied different gutted weight to whole weight conversions, it was decided that we should first convert the whole landings in whole weight back to their original gutted weight using the state-specific conversions. The state-specific gutted to whole weight conversions are as follows: Florida and Georgia multiply gutted weight by 1.11 to obtain whole weight, South Carolina divides gutted weight by 0.9 (quite similar to multiplying by 1.11), and North Carolina multiplies gutted weight by 1.08. The inverse of these processes was used in back transforming to gutted weight. Landings in gutted weight were then converted to whole weight by multiplying by the common biologically-based conversion factor (1.068, $r^2 = 0.994$; see Life History Section). Annual landings in whole weight are summarized by region (Table 3.1 and Figure 3.5) and by gear (Table 3.2 and Figure 3.6). Additionally, annual landings in gutted weight are summarized by gear in Table 3.2a.

A comparison was made of total commercial landings for US south Atlantic vermilion snappers between the recent updated assessment (to SEDAR 2) and the data presented here for SEDAR 17 for the period 1970-2007 (Figure 3.7). They match very closely. The largest deviation (23%) was in 1971 when landings were still low, but otherwise an average magnitude of 3.7% over the entire period 1970-2007, and 2.3% since 1990. Some of the differences are due to difference in defining the southern boundary with the Gulf of Mexico, some to ongoing corrections to data bases, and some to differences in proportioning unclassified snappers into vermilion snappers. Overall the differences are small.

Combined Landings in Numbers – Conversion of commercial landings in weight to numbers is based on mean weights obtained from TIP length sampling by state, gear and year. First sampled lengths are converted to weight using the weight length relation given in the Life History Section. When TIP length samples were inadequate (N<20) or non-existent, a weighted average of available weight was obtained by averaging across years, either prior to 1992 or 1992 and later (Table 3.3). The year 1992 was selected because of the implementation that year of a minimum size limit. Trawl data was so limited (and landings very small) after 1992, that only an overall mean was obtained. Landings in numbers are summarized by region (Table 3.4 and Figure 3.8) and by state (Table 3.5 and Figure 3.9).

Uncertainty in Commercial Landings – The Workgroup discussed the uncertainty that may be associated with estimates of commercial landings. In past assessments this discussion was framed about coefficients of variation (CV = standard deviation/mean) and how CVs may have varied over time. The CV was thought to have been high in the early years prior to the start of the ALS in 1962 (see Appendix on ALS). Meanwhile, the CV was thought to be relatively low in recent years, subsequent to North Carolina's trip ticket program in 1994. During the discussion, it was suggested that further improvements were associated with the transfer of responsibility for collection and processing to the SEFSC in 1978 and beginning of state-federal co-operation. Between the late 1978 and 1994, a series of improvements occurred, such as the Florida trip ticket in 1985/1986. Hence, a low CV of 10% was chosen for the recent period (1994-present), high CV of 40% for pre-ALS data, 30% for the early years of the ALS, and a linear interpolation from 30% to 10% form 1978-1994 (Figure 3.10). The Workgroup suggests that these CVs may serve as the basis for developing alternate landings streams for sensitivity model runs.

3.3. Commercial Price

Price per pound was estimated for vermilion snapper sold in the South Atlantic states from the ALS database for the years 1962 through 2006. The Producer Price Index (PPI) for "prepared fresh fish and other seafood" was obtained from the U.S. Bureau of Labor Statistics website (data.bls.gov), available since 1965. The PPI, like the CPI, is an index that reflects inflation. But the difference here is that the PPI reflects the costs associated with bringing the product to market. In other words, this PPI reflects more closely the changed in costs to fishermen and processors such as trip costs. Using 1965 as base year, observed price per pound was adjusted to obtain inflation-adjusted values for the price per pound. Unadjusted and adjusted price per pound are compared in Figure 3.11. The actual price the fishermen received noted a general upwards trend from approximately $0.23 on average in 1965 to $2.77 per pound in 2007.The PPI-calculated values held the value of one dollar constant throughout the time series, and show an actual decline over time. The PPI-adjusted value for 2007 was $0.19.

3.4. Commercial Discards

The report titled '***Discards of Spanish Mackerel and Vermilion Snapper Calculated for Commercial Vessels with Federal Fishing Permits in the US South Atlantic***' was prepared by Kevin McCarthy (**SEDAR 17-DW10**). A brief summary of the results and discussion for vermilion snapper follows:

Calculated total discards for each region are provided for vermilion snapper discarded from handline vessels. The calculated discards from each region were summed by year to provide yearly total vermilion snapper handline vessel discards (Table 3.6). Discards of vermilion snapper often exceeded 100,000 fish, although in recent years the number of discards has decreased to approximately 50,000 fish. There appears to be a trend among fishers in the south Atlantic to report “no discards” more frequently in recent years than during the first few years of the discard logbook program. The degree of impact of such reporting, resulting in more “no discard” trips, is unknown.

More than 85% of vermilion snapper released in regions 1-4 were reported as “alive” or “majority alive”. Discards in region 5, however, were frequently reported (70%) as majority dead. The reason reported for almost all (98-99%) vermilion snapper discards was regulations.

The number of trips reporting vermilion snapper in the US south Atlantic was very low and the number of individuals of those species reported as discarded was also low. Stratification of the available data was limited because of the small sample sizes and, therefore, likely does not capture much of the variation in numbers of discards within the vermilion snapper fisheries. How that may affect the number of calculated discards (over or under estimate) is unknown.

A minimum size limit of 12” TL was instituted in 1992 through Snapper-Grouper Amendment 4. Discussion by the Workgroup suggested that prior to 1992, discards were likely to be minimal. Expansion of estimates back to 1992 using logbook effort was accepted by the Workgroup as reasonable.

Decision 7. The Workgroup accepted these estimates of vermilion snapper discards in the handline fisheries for 1992-2007.

3.5 Biological Sampling

3.5.1 Length Distributions

Length samples have been collected by the Trip Interview Program (TIP) and several state agencies since 1981. These samples are collected by port agents at docks where commercial catches are landed throughout the US South Atlantic coasts. Trips are randomly sampled to obtain trip, effort, catch and length frequency information. Occasionally there has been quota sampling to obtain age structures on fish that are rare in the catch (extremely large and small fish). These non-random samples are identified in the data to allow removal from analyses were non-random samples are not appropriate.

Sample data were obtained from the TIP data set (NMFS/SEFSC), which contains information from commercial, recreational and research programs. The data used where a subset of this data set, which contained commercial samples that were identified as having no sampling bias (Table 3.7). These data were further limited to those that could be assigned a year, gear, state and area. Data that had unknown year sampled, gear used or sampling state were deleted from the file.

Sample data were joined with landings data by year, gear and state. Landings data were also limited to those data that could be assigned a year, gear, and state. Landings and sample data were assigned a state based on landing and sample location.

Length data were converted to cm total length and binned by one centimeter group with a floor of 0.5 cm and a ceiling of 0.4 cm. Length was converted to weight (whole weight in

Kg) using conversions provided by the life history group. The length data and landings data were broken into handline and trawl gears. Length compositions were weighted by expanding the number of lengths in each strata (gear, state, year) by the landings in numbers (relative frequency in stratum x landings in numbers for the stratum).

Annual length compositions of vermilion snapper for handline and trawl gears are summarized in Figures 3.12 – 3.13.

Market category comparison: It was suggested that we use market category to obtain size trends in landings data. To accomplish this task we would need to allocate landings by size based on market grade. As noted below, definition of market grade varied between states.

Landings are mostly available by market grade for vermilion snapper for 1994-2007 (Figure 3.14). Less than 1% were in the mixed grade for North Carolina, about 3% from South Carolina, less than 1% for Georgia, but about 60% from Florida. The mixed grade here includes both those landings designated as 'mixed' and those with no grade given. For purposes of this summary, categories for <1 pound (used by NC & GA) are referred to as Small, and categories for >2 pounds are referred to as large. The category for 1-2 pounds is referred to as Medium. Overall, 89% of the vermilion snapper landings were available by market grade (generally small, medium and large).

Of the 231,321 length samples obtained for vermilion snapper, only 81,194 had a market category assigned. It was felt that having only 35% of the samples with market grade was inadequate to allocate landings at size by market grade.

3.5.2 Age Distributions

Sample size of vermilion snapper ages are summarized by gear from commercial landings in the US Atlantic for 1992-2007 (Table 3.8). Age compositions were developed for handlines (1992-2007, Figure 3.15) gear types. Weighting is initially between states weight by state landings in numbers, and then by length composition shown in Figure 3.14. This latter weighting corrects for a potential sampling bias of age samples relative to length samples (see Section 3 in SEDAR10 for South Atlantic gag).

3.5.3 Adequacy for characterizing lengths and ages

Length sampling has been extensive for vermilion snapper from the handline fishery, with more than 231,000 fish sample for length. These samples are reasonably well distributed by state (10% from FL, 17% from GA, 50% from SC, and 23% from NC). An average of 9,377 fish sampled were available annually from 1984-2007. Samples were only available from North Carolina in 1983, and since 1984, state samples were lacking only in 1984 and 1987 from Florida, and 1990 from Georgia. Length sampling of vermilion snapper from trawls is much more limited, with a total of 2,218 fish lengths collected between 1984 and 1988 and in 1997. An additional 3,660 fish lengths were categorized as Other gear.

Of the 5,010 aged vermilion snapper, 4,985 of them are from the commercial handline fishery. Of the remain 25 ages, 8 were collected from “butterfly/wing net” gear, 6 from “diver” gear, and 11 from “trap” gear. The ages from handline gear are distributed among the states as follows: 1,727 from Atlantic Florida, 3 from Georgia, 1,276 from South Carolina, and 1,979 from North Carolina. Of particular concern was that all samples collected between 1997 and 2002 were from Atlantic Florida. Obviously, no post-stratification of samples by state is possible for these years. Any age composition for these years is representative of Florida alone, and not necessarily of the coastwide stock.

3.6 Research Recommendations for Vermilion snapper

- Still need observer coverage for the snapper-grouper fishery
  - 5-10% allocated by strata within states
  - possible to use exemption to bring in everything with no sale
  - get maximum information from fish
- Expand TIP sampling to better cover all statistical strata
  - Predominantly by H&L gear
  - In that sense, we have decent coverage for lengths
- Trade off with lengths versus ages, need for more ages (i.e., hard parts)
- Workshop to resolve historical commercial landings for a suite of snapper-grouper species
  - Monroe County (SA-GoM division)
  - Species identification (mis-identification and unclassified)

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Addendum to Commercial Landings (Section 3.2):

NMFS SEFIN Accumulated Landings (ALS)

Information on the quantity and value of seafood products caught by fishermen in the U.S. has been collected as early as the late1890s. Fairly serious collection activity began in the 1920s. The data set maintained by the Southeast Fisheries Science Center (SEFSC) in the SEFIN database management system is a continuous data set that begins in 1962.

In addition to the quantity and value, information on the gear used to catch the fish, the area where the fishing occurred and the distance from shore are also recorded. Because the quantity and value data are collected from seafood dealers, the information on gear and fishing location are estimated and added to the data by data collection specialists. In some states, this ancillary data are not available.

Commercial landings statistics have been collected and processed by various organizations during the 1962-to-present period that the SEFIN data set covers. During the 16 years from 1962 through 1978, these data were collected by port agents employed by the Federal government and stationed at major fishing ports in the southeast. The program was run from the Headquarters Office of the Bureau of Commercial Fisheries in Washington DC. Data collection procedures were established by Headquarters and the data were submitted to Washington for processing and computer storage. In 1978, the responsibility for collection and processing were transferred to the SEFSC.

In the early 1980s, the NMFS and the state fishery agencies within the Southeast began to develop a cooperative program for the collection and processing of commercial fisheries statistics. With the exception of two counties, one in Mississippi and one in Alabama, all of the general canvass statistics are collected by the fishery agency in the respective state and provided to the SEFSC under a comprehensive Cooperative Statistics Program (CSP).

The purpose of this documentation is to describe the current collection and processing procedures that are employed for the commercial fisheries statistics maintained in the SEFIN database.

1960 - Late 1980s
=================
Although the data processing and database management responsibility were transferred from the Headquarters in Washington DC to the SEFSC during this period, the data collection procedures remained essentially the same. Trained data collection personnel, referred to as fishery reporting specialists or port agents, were stationed at major fishing ports throughout the Southeast Region. The data collection procedures for commercial landings included two parts.

The primary task for the port agents was to visit all seafood dealers or fish houses within their assigned areas at least once a month to record the pounds and value for each species or product type that were purchased or handled by the dealer or fish house. The agents summed the landings and value data and submitted these data in monthly reports to their area supervisors. All of the monthly data were submitted in essentially the same form.

The second task was to estimate the quantity of fish that were caught by specific types of gear and the location of the fishing activity. Port agents provided this gear/area information for all of the landings data that they collected. The objective was to have gear and area information assigned to all monthly commercial landings data.

There are two problems with the commercial fishery statistics that were collected from seafood dealers. First, dealers do not always record the specific species that are caught and second, fish or shellfish are not always purchased at the same location where they are unloaded, i.e., landed.

Dealers have always recorded fishery products in ways that meet their needs, which sometimes make it ambiguous for scientific uses. Although the port agents can readily identify individual species, they usually were not at the fish house when fish were being unloaded and thus, could not observe and identify the fish.

The second problem is to identify where the fish were landed from the information recorded by the dealers on their sales receipts. The NMFS standard for fisheries statistics is to associate commercial statistics with the location where the product was first unloaded, i.e., landed, at a shore-based facility. Because some products are unloaded at a dock or fish house and purchased and transported to another dealer, the actual 'landing' location may not be apparent from the dealers' sales receipts. Historically, communications between individual port agents and the area supervisors were the primary source of information that was available to identify the actual unloading location.

Cooperative Statistics Program
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In the early 1980s, it became apparent that the collection of commercial fisheries statistics was an activity that was conducted by both the Federal government and individual state fishery agencies. Plans and negotiations were initiated to develop a program that would provide the fisheries statistics that are needed for management by both Federal and state agencies. By the mid- 1980s, formal cooperative agreements had been signed between the NMFS/SEFSC and each of the eight coastal states in the southeast, Puerto Rico and the US Virgin Islands.

Initially, the data collection procedures that were used by the states under the cooperative agreements were essentially the same as the historical NMFS procedures. As the states developed their data collection programs, many of them promulgated legislation that authorized their fishery agencies to collect fishery statistics. Many of the state statutes include mandatory data submission by seafood dealers.

Because the data collection procedures (regulations) are different for each state, the type and detail of data varies throughout the Region. The commercial landings database maintained in SEFIN contains a standard set of data that is consistent for all states in the Region.

A description of the data collection procedures and associated data submission requirements for each state follows.

Florida
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Prior to 1986, commercial landings statistics were collected by a combination of monthly mail submissions and port agent visits. These procedures provided quantity and value, but did not provide information on gear, area or distance from shore. Because of the large number of dealers, port agents were not able to provide the gear, area and distance information for monthly data. This information, however, is provided for annual summaries of the quantity and value and known as the Florida Annual Canvas data (see below).

Beginning in 1986, mandatory reporting by all seafood dealers was implemented by the State of Florida. The State requires that a report (ticket) be completed and submitted to the State for every trip. Dealers have to report the type of gear as well as the quantity (pounds) purchased for each species. Information on the area of catch can also be provided on the tickets for individual trips. As of 1986 the ALS system relies solely on the Florida trip ticket data to create the ALS landings data for all species other than shrimp.

Georgia
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Prior to 1977, the National Marine Fisheries Service collected commercial landings data Georgia. From 1977 to 2001 state port agents visited dealers and docks to collect the information on a regular basis. Compliance was mandatory for the fishing industry. To collect more timely and accurate data, Georgia initiated a trip ticket program in 1999, but the program was not fully implemented to allow complete coverage until 2001. All sales of seafood products landed in Georgia must be recorded on a trip ticket at the time of the sale. Both the seafood dealer and the seafood harvester are responsible for insuring the ticket is completed in full.

South Carolina
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Prior to 1972, commercial landings data were collected by various federal fisheries agents based in South Carolina, either U.S. Fish or Wildlife or National Marine Fisheries Service personnel. In 1972, South Carolina began collecting landings data from coastal dealers in cooperation with federal agents. Mandatory monthly landings reports on forms supplied by the Department are required from all licensed wholesale dealers in South Carolina. Until fall of 2003, those reports were summaries collecting species, pounds landed, disposition (gutted or whole) and market category, gear type and area fished; since September 2003, landings have been reported by a mandatory trip ticket system collecting landings by species, disposition and market category, pounds landed, ex-vessel prices with associated effort data to include gear type and amount, time fished, area fished, vessel and fisherman information.

South Carolina began collecting TIP length frequencies in 1983 as part of the Cooperative Statistics Program. Target species and length quotas were supplied by NMFS and sampling targets of 10% of monthly commercial trips by gear were set to collect those species and length frequencies. In 2005, South Carolina began collecting age structures (otoliths) in addition to length frequencies, using ACCSP funding to supplement CSP funding.

North Carolina

The National Marine Fisheries Service prior to 1978 collected commercial landings data for North Carolina. Port agents would conduct monthly surveys of the state's major commercial seafood dealers to determine the commercial landings for the state. Starting in 1978, the North Carolina Division of Marine Fisheries entered into a cooperative program with the National Marine Fisheries Service to maintain the monthly surveys of North Carolina's major commercial seafood dealers and to obtain data from more dealers.

The North Carolina Division of Marine Fisheries Trip Ticket Program (NCTTP) began on 1 January 1994. The NCTTP was initiated due to a decrease in cooperation in reporting under the voluntary NMFS/North Carolina Cooperative Statistics Program in place prior to 1994, as well as an increase in demand for complete and accurate trip-level commercial harvest statistics by fisheries managers. The detailed data obtained through the NCTTP allows for the calculation of effort (i.e. trips, licenses, participants, vessels) in a given fishery that was not available prior to 1994 and provides a much more detailed record of North Carolina's seafood harvest.

NMFS SEFIN Annual Canvas Data for Florida

The Florida Annual Data files from 1976 – 1996 represent annual landings by county (from dealer reports) which are broken out on a percentage estimate by species, gear, area of capture, and distance from shore. These estimates are submitted by Port agents, which were assigned responsibility for the particular county, from interviews and discussions from dealers and fishermen collected through out the year. The estimates are processed against the annual landings totals by county on a percentage basis to create the estimated proportions of catch by the gear, area and distance from shore. (The sum of percentages for a given Year, State, County, Species combination will equal 100.)

Area of capture considerations: ALS is considered to be a commercial landings data base which reports where the marine resource was landed. With the advent of some State trip ticket programs as the data source the definition is more loosely applied. As such one cannot assume reports from the ALS by State or county will accurately inform you of Gulf vs South Atlantic vs Foreign catch. To make that determination you must consider the area of capture.

Table 3.1. Vermilion snapper commercial landings (pounds whole weight) by region for the US South Atlantic.

US South Atlantic - Region			
Year	Florida	Georgia-North Carolina	Total
1958	194	0	194
1959	1,262	0	1,262
1960	1,747	0	1,747
1961	19,317	24,025	43,341
1962	5,921	46,416	52,337
1963	11,357	9,610	20,967
1964	6,504	288	6,792
1965	19,511	2,499	22,009
1966	3,397	0	3,397
1967	14,172	0	14,172
1968	31,936	0	31,936
1969	30,771	577	31,347
1970	19,511	0	19,511
1971	50,185	16,532	66,717
1972	65,910	14,674	80,584
1973	80,956	11,349	92,305
1974	99,399	22,716	122,115
1975	188,702	32,778	221,481
1976	147,060	72,871	219,931
1977	143,325	141,294	284,619
1978	111,621	234,501	346,122
1979	142,923	342,127	485,049
1980	104,167	639,606	743,774
1981	57,452	683,042	740,494
1982	59,883	821,176	881,059
1983	79,469	708,856	788,324
1984	91,272	740,104	831,376
1985	126,730	803,647	930,377
1986	97,309	811,742	909,051
1987	67,938	658,903	726,841
1988	86,039	858,204	944,243
1989	111,962	940,541	1,052,503
1990	177,766	1,000,215	1,177,981
1991	209,274	1,160,700	1,369,974
1992	175,165	589,924	765,089
1993	162,845	709,605	872,450
1994	214,948	734,453	949,400
1995	259,597	670,062	929,660
1996	185,076	559,338	744,414
1997	117,230	643,156	760,386
1998	93,005	615,773	708,778
1999	96,791	780,943	877,734

Table 3.1. (cont.)

2000	153,254	1,195,751	1,349,005
2001	186,992	1,446,927	1,633,919
2002	177,153	1,158,126	1,335,279
2003	112,461	615,698	728,160
2004	167,164	919,288	1,086,452
2005	146,429	955,259	1,101,688
2006	162,808	665,232	828,040
2007	176,641	838,906	1,015,547

Table 3.2. Vermilion snapper commercial landings (pounds whole weight) by gear for the US South Atlantic.

US South Atlantic - Gear				
Year	Handlines	Trawl	Other	Total
1958	194	0	0	194
1959	1,262	0	0	1,262
1960	1,747	0	0	1,747
1961	19,317	24,025	0	43,341
1962	10,822	42,582	0	53,405
1963	20,967	0	0	20,967
1964	6,792	0	0	6,792
1965	21,913	96	0	22,009
1966	3,397	0	0	3,397
1967	14,172	0	0	14,172
1968	31,936	0	0	31,936
1969	31,347	0	0	31,347
1970	19,511	0	0	19,511
1971	66,321	395	0	66,717
1972	68,794	0	11,790	80,584
1973	86,193	1,922	4,190	92,305
1974	119,387	0	2,728	122,115
1975	218,655	729	2,096	221,481
1976	212,410	7,144	378	219,931
1977	273,322	10,985	312	284,619
1978	345,076	1,047	0	346,122
1979	430,888	54,161	0	485,049
1980	482,636	268,613	0	751,249
1981	500,886	242,732	161	743,779
1982	672,796	215,630	36	888,462
1983	645,732	142,058	725	788,514
1984	734,077	117,694	262	852,032
1985	920,506	24,028	955	945,490
1986	896,379	10,587	13,390	920,356
1987	697,928	23,627	28,004	749,560
1988	854,227	89,294	42,243	985,765
1989	1,041,509	1,232	88,834	1,131,575
1990	1,141,190	4,613	144,100	1,289,902
1991	1,332,693	4,146	57,272	1,394,111
1992	764,936	33	244	765,214
1993	866,361	58	8,494	874,913
1994	948,426	0	9,734	958,160
1995	928,497	6	2,870	931,374
1996	743,692	40	1,354	745,087
1997	759,005	0	2,012	761,017
1998	708,112	1,101	1,293	710,506
1999	876,584	386	4,124	881,093

Table 3.2. (cont.)

2000	1,348,519	0	1,592	1,350,111
2001	1,633,594	0	3,230	1,636,824
2002	1,334,418	67	1,271	1,335,756
2003	727,859	0	6,970	734,829
2004	1,086,300	378	2,298	1,088,976
2005	1,100,916	2	869	1,101,787
2006	827,160	0	1,460	828,620
2007	1,012,612	0	7,693	1,020,305

Table 3.2a. Vermilion snapper commercial landings (pounds gutted weight) by gear for the US South Atlantic.

US South Atlantic - Gear				
Year	Handlines	Trawl	Other	Total
1958	182	0	0	182
1959	1,182	0	0	1,182
1960	1,636	0	0	1,636
1961	18,091	22,500	0	40,591
1962	10,135	39,880	0	50,015
1963	19,636	0	0	19,636
1964	6,361	[o]0	0	6,361
1965	20,523	90	0	20,613
1966	3,182	0	0	3,182
1967	13,273	0	0	13,273
1968	29,909	0	0	29,909
1969	29,358	0	0	29,358
1970	18,273	0	0	18,273
1971	62,113	370	0	62,483
1972	64,428	0	11,042	75,470
1973	80,723	1,800	3,924	86,447
1974	111,811	0	2,555	114,365
1975	204,780	683	1,963	207,425
1976	198,930	6,691	354	205,974
1977	255,977	10,288	292	266,557
1978	323,177	980	0	324,157
1979	403,544	50,724	0	454,268
1980	452,008	251,567	0	703,575
1981	469,100	227,328	151	696,579
1982	630,101	201,946	33	832,080
1983	604,754	133,043	679	738,475
1984	687,492	110,225	246	797,963
1985	862,091	22,504	895	885,489
1986	839,495	9,915	12,540	861,951
1987	653,638	22,128	26,227	701,993
1988	800,018	83,627	39,562	923,208
1989	975,415	1,153	83,196	1,059,765
1990	1,068,770	4,320	134,955	1,208,045
1991	1,248,121	3,883	53,637	1,305,641
1992	716,394	31	229	716,653
1993	811,382	54	7,955	819,391
1994	888,239	0	9,116	897,355
1995	869,575	6	2,688	872,269
1996	696,498	37	1,268	697,803
1997	710,839	0	1,884	712,723
1998	663,175	1,031	1,211	665,418
1999	820,956	361	3,862	825,179

Table 3.2a. (cont.)

2000	1,262,942	0	1,491	1,264,433
2001	1,529,926	0	3,025	1,532,952
2002	1,249,736	63	1,190	1,250,989
2003	681,669	0	6,528	688,197
2004	1,017,363	354	2,152	1,019,870
2005	1,031,052	2	814	1,031,867
2006	774,668	0	1,368	776,036
2007	948,352	0	7,204	955,556

Table 3.3. Mean weights (pounds) from TIP samples used to convert vermilion snapper commercial landings from pounds (whole weight) to numbers. Weights in shaded areas represent areas of insufficient (N<20) or no samples, and weighted means across years are used (split at 1992 with introduction of minimum size limit for vermilion snapper, except for trawl which had limited data mostly prior to 1992).

	Florida			Georgia			South Carolina			North Carolina		
Year	Handlines	Trawl	Other	Handlines	Trawl	Other	Handlines	Trawl	Other	Handlines	Trawl	Other
1958	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1959	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1960	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1961	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1962	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1963	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1964	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1965	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1966	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1967	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1968	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1969	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1970	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1971	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1972	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1973	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1974	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1975	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1976	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1977	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1978	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1979	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356

Table 3.3. (cont.)

1980	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1981	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1982	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.537	0.503	1.356
1983	1.138	0.736	1.468	1.036	0.227	1.111	1.069	0.503	0.745	1.967	0.503	1.356
1984	1.138	0.736	1.468	0.973	0.227	1.111	1.096	0.525	0.745	1.785	0.503	2.015
1985	1.173	0.736	1.468	1.070	0.227	1.111	1.161	0.503	0.745	1.800	0.503	1.753
1986	1.063	0.736	1.468	0.942	0.227	1.111	1.028	0.329	0.745	1.578	0.503	1.356
1987	1.138	0.736	1.468	1.081	0.227	1.111	1.055	0.288	1.700	1.360	0.503	1.534
1988	0.694	0.736	1.468	1.029	0.227	1.111	1.030	0.737	0.745	1.341	0.503	1.356
1989	0.840	0.736	1.468	1.320	0.227	1.111	1.100	0.503	0.745	1.396	0.503	1.356
1990	1.415	0.736	1.468	1.036	0.227	1.111	1.024	0.503	0.742	1.353	0.503	1.356
1991	1.171	0.736	1.468	1.066	0.227	1.111	1.008	0.503	0.704	1.510	0.503	0.857
1992	1.317	0.736	1.731	1.226	0.227	1.407	1.259	0.503	1.355	1.385	0.503	1.118
1993	1.275	0.736	1.402	1.328	0.227	1.407	1.466	0.503	1.074	1.562	0.503	1.387
1994	1.427	0.736	1.257	1.580	0.227	1.407	1.348	0.503	1.066	1.755	0.503	1.387
1995	1.231	0.736	1.305	1.319	0.227	1.407	1.283	0.503	0.987	1.568	0.503	1.755
1996	1.096	0.736	1.475	1.176	0.227	1.407	1.293	0.503	1.131	1.631	0.503	1.387
1997	0.925	0.736	1.177	1.433	0.227	1.407	1.332	0.503	1.131	1.814	0.503	1.387
1998	1.023	0.736	1.475	1.242	0.227	1.407	1.243	0.503	1.131	1.568	0.503	1.387
1999	1.231	0.736	1.927	1.185	0.227	1.407	1.339	0.503	1.105	1.738	0.503	1.387
2000	1.270	0.736	1.545	1.211	0.227	1.407	1.504	0.503	1.131	1.709	0.503	1.387
2001	1.192	0.736	0.992	1.198	0.227	1.407	1.768	0.503	1.131	1.723	0.503	1.387
2002	1.427	0.736	1.475	1.006	0.227	1.407	1.724	0.503	1.131	1.580	0.503	0.938
2003	1.345	0.736	1.385	1.155	0.227	1.407	1.440	0.503	1.131	1.734	0.503	0.798
2004	1.144	0.736	1.872	1.268	0.227	1.407	1.451	0.503	1.131	1.784	0.503	1.387
2005	1.965	0.736	1.475	1.241	0.227	1.407	1.558	0.503	1.131	1.905	0.503	1.387
2006	1.384	0.736	1.080	1.281	0.227	1.407	1.613	0.503	1.272	1.409	0.503	1.387
2007	1.429	0.736	1.554	1.251	0.227	1.407	1.700	0.503	1.131	1.624	0.503	1.387

Table 3.4. Vermilion snapper commercial landings (number of fish) by region for the US South Atlantic.

US South Atlantic - Region			
Year	Florida	Georgia-North Carolina	Total
1958	171	0	171
1959	1,109	0	1,109
1960	1,536	0	1,536
1961	16,981	47,796	64,776
1962	5,205	87,174	92,379
1963	9,984	8,988	18,971
1964	5,717	270	5,987
1965	17,151	2,438	19,589
1966	2,987	0	2,987
1967	12,458	0	12,458
1968	28,073	0	28,073
1969	27,049	539	27,589
1970	17,151	0	17,151
1971	44,115	13,994	58,110
1972	57,939	18,447	76,386
1973	71,165	12,207	83,371
1974	87,377	16,025	103,402
1975	165,880	22,763	188,643
1976	129,274	74,305	203,579
1977	125,991	136,598	262,589
1978	98,121	184,799	282,920
1979	125,637	308,054	433,691
1980	91,569	839,342	930,911
1981	50,503	863,351	913,854
1982	52,640	883,307	935,947
1983	69,858	674,836	744,694
1984	80,233	662,808	743,041
1985	108,053	572,795	680,848
1986	91,574	654,780	746,354
1987	59,721	617,793	677,515
1988	123,895	765,528	889,423
1989	133,295	749,411	882,705
1990	125,597	855,116	980,713
1991	178,767	974,169	1,152,935
1992	132,980	446,721	579,701
1993	127,701	474,905	602,606
1994	150,677	464,535	615,212
1995	210,940	467,120	678,060
1996	168,899	386,183	555,082
1997	126,742	409,674	536,416
1998	90,906	439,053	529,959
1999	78,599	519,176	597,775

Table 3.4. (cont.)

2000	120,687	790,029	910,717
2001	156,853	892,210	1,049,063
2002	124,177	788,125	912,302
2003	83,596	418,574	502,170
2004	146,174	608,877	755,051
2005	74,505	589,367	663,873
2006	117,622	458,079	575,701
2007	123,583	526,934	650,517

Table 3.5. Vermilion snapper commercial landings (number of fish) by gear for the US South Atlantic.

US South Atlantic - Gear				
Year	Handlines	Trawl	Other	Total
1958	171	0	0	171
1959	1,109	0	0	1,109
1960	1,536	0	0	1,536
1961	16,981	47,796	0	64,776
1962	9,789	84,041	0	93,830
1963	18,971	0	0	18,971
1964	5,987	0	0	5,987
1965	19,398	191	0	19,589
1966	2,987	0	0	2,987
1967	12,458	0	0	12,458
1968	28,073	0	0	28,073
1969	27,589	0	0	27,589
1970	17,151	0	0	17,151
1971	57,323	787	0	58,110
1972	60,636	0	15,750	76,386
1973	74,713	3,824	4,834	83,371
1974	100,945	0	2,457	103,402
1975	185,646	1,451	1,546	188,643
1976	189,088	14,212	278	203,579
1977	240,453	21,854	282	262,589
1978	280,838	2,082	0	282,920
1979	325,940	107,750	0	433,691
1980	357,195	583,869	0	941,063
1981	368,744	549,355	217	918,316
1982	498,435	447,518	48	946,001
1983	450,452	293,527	972	744,952
1984	537,073	233,668	352	771,094
1985	661,446	38,901	634	700,980
1986	707,569	36,310	10,713	754,591
1987	579,273	95,483	18,544	693,301
1988	767,280	121,199	29,802	918,282
1989	867,969	1,673	67,751	937,393
1990	932,265	6,264	121,533	1,060,062
1991	1,100,717	5,631	65,834	1,172,181
1992	579,589	45	165	579,800
1993	597,861	79	6,460	604,400
1994	614,384	0	7,798	622,182
1995	676,946	9	2,423	679,378
1996	554,515	54	996	555,565
1997	535,384	0	1,568	536,952
1998	529,449	1,496	934	531,879
1999	596,778	524	2,541	599,842

Table 3.5. (cont.)

2000	910,351	0	1,082	911,432
2001	1,048,806	0	3,186	1,051,991
2002	911,483	91	1,097	912,671
2003	501,902	0	5,086	506,987
2004	754,923	514	1,274	756,711
2005	663,194	3	744	663,941
2006	575,021	0	1,217	576,238
2007	647,950	0	5,628	653,578

Table 3.6. Calculated yearly south Atlantic handline vessel vermilion snapper discards by region and for US South Atlantic. Discards are reported in number of fish. Regions are defined as follows: 1 = 24^o to <30^o N latitude, 2 = 30^o to <32^o N latitude, 3 = 32^o to <33^o N latitude, 4 = 33^o to <34^o N latitude, 5 = 34^o to <37^o N latitude.

Sum of Calculated Discards	Region					
Year	1	2	3	4	5	Grand Total
1992	4425	29823	24284	14188	2304	75024
1993	3338	27587	31466	18447	3433	84271
1994	3849	28352	35991	33385	4030	105607
1995	4016	37900	48481	33685	3375	127457
1996	4749	60562	59739	34237	5058	164345
1997	5811	50786	58787	31345	5967	152696
1998	4746	33432	47262	29710	4653	119803
1999	4351	30868	33153	27830	3875	100077
2000	4365	28015	39264	29863	3275	104782
2001	3923	34586	55117	27503	3779	124908
2002	5614	12825	131925	79880	6776	237020
2003	9044	17251	16816	53702	1471	98284
2004	304	14685	5303	29467	3	49762
2005	5363	52768	4454	12104	256	74945
2006	133	19423	13950	13225	462	47193
2007	353	33982	4595	5279	7565	51774
Grand Total	64384	512845	610587	473850	56282	1717948

Table 3.7. Vermilion snapper lengths sampled from the commercial fishery and available in the TIP data base, 1983-2007.

	HANDLINE				TRAWL			
Year	FL	GA	NC	SC	FL	GA	NC	SC
1983	0	0	391	0	0	0	0	0
1984	0	1,242	4,797	1,937	0	0	0	196
1985	636	1,422	5,265	2,477	0	0	0	0
1986	43	1,281	4,954	1,610	0	0	0	650
1987	0	741	4,604	1,970	0	366	0	250
1988	175	795	3,223	1,384	0	0	0	692
1989	19	362	3,846	1,398	0	0	0	0
1990	192	0	4,348	1,467	0	0	0	0
1991	317	905	6,397	2,906	0	0	0	0
1992	1,416	819	2,859	1,067	0	0	0	0
1993	1,476	716	4,918	1,176	0	0	0	0
1994	457	767	5,374	890	0	0	0	0
1995	2,348	4,200	5,732	966	0	0	0	0
1996	776	1,402	2,519	2,021	0	0	0	0
1997	1,276	866	1,559	3,092	64	0	0	0
1998	1,782	233	1,557	3,072	0	0	0	0
1999	2,949	1,125	4,013	3,874	0	0	0	0
2000	4,219	2,115	7,815	4,563	0	0	0	0
2001	1,843	4,554	7,139	4,498	0	0	0	0
2002	709	3,377	4,560	3,378	0	0	0	0
2003	1,044	3,613	4,151	3,169	0	0	0	0
2004	94	5,837	5,334	2,193	0	0	0	0
2005	116	1,242	5,261	1,985	0	0	0	0
2006	987	1,529	7,562	1,046	0	0	0	0
2007	749	85	4,622	1,313	0	0	0	0

Table 3.8. Vermilion snapper ages sampled from the commercial handline fishery by state, 1992-2007. Excludes a total of 25 aged fish from miscellaneous gears (Other), sampled 2005-2007.

Year	Florida	Georgia	South Carolina	North Carolina	Total
1992	9		73		82
1993	74		15	94	183
1994	120		24	20	164
1995	263	3	1	50	317
1996					0
1997	55				55
1998	104				104
1999	136				136
2000	209				209
2001	244				244
2002	181				181
2003	74			48	122
2004	159			353	512
2005	59		209	459	727
2006			477	461	938
2007	40		477	494	1011
Total	1727	3	1276	1979	4985

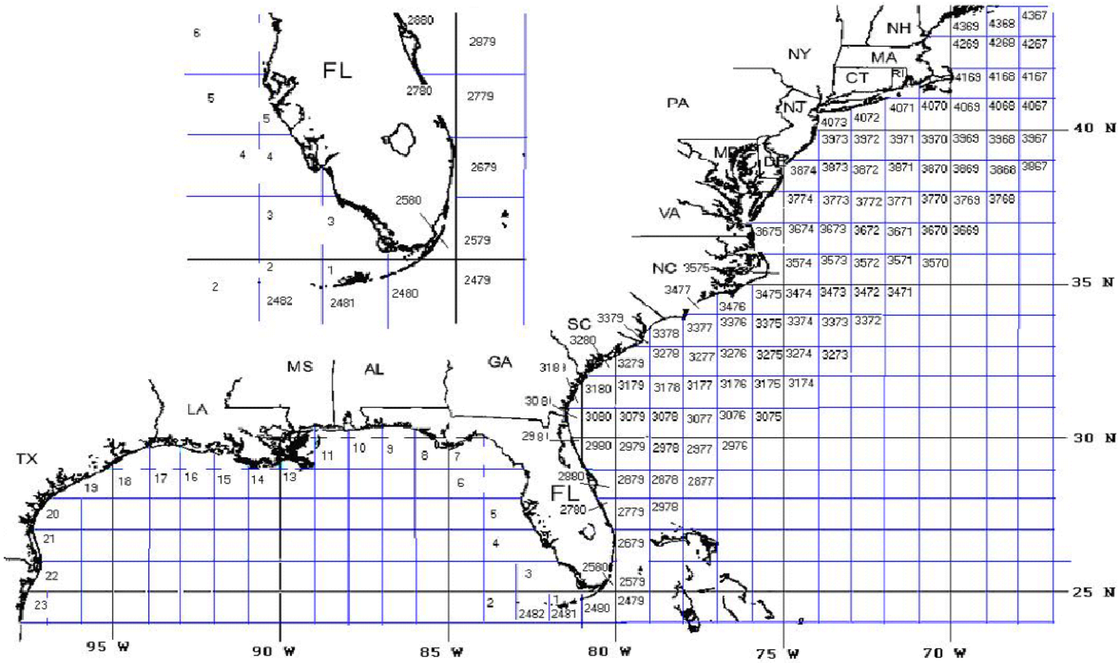


Figure 3.1. Map of U.S. Atlantic and Gulf coast with shrimp area designations.

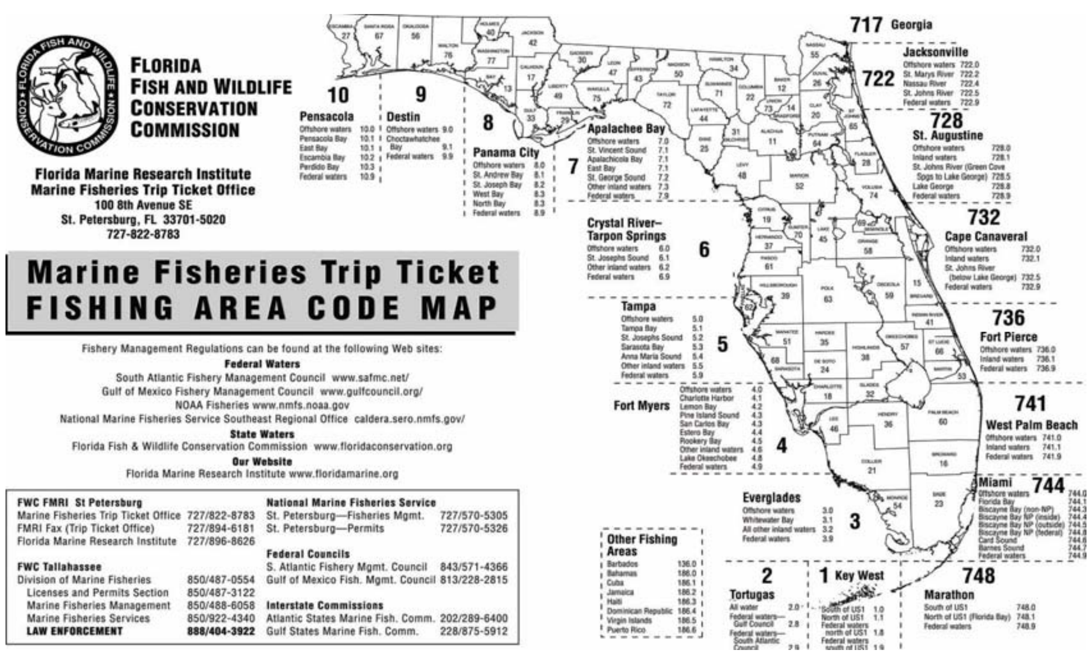


Figure 3.2. Map showing marine fisheries trip ticket fishing area code map for Florida.

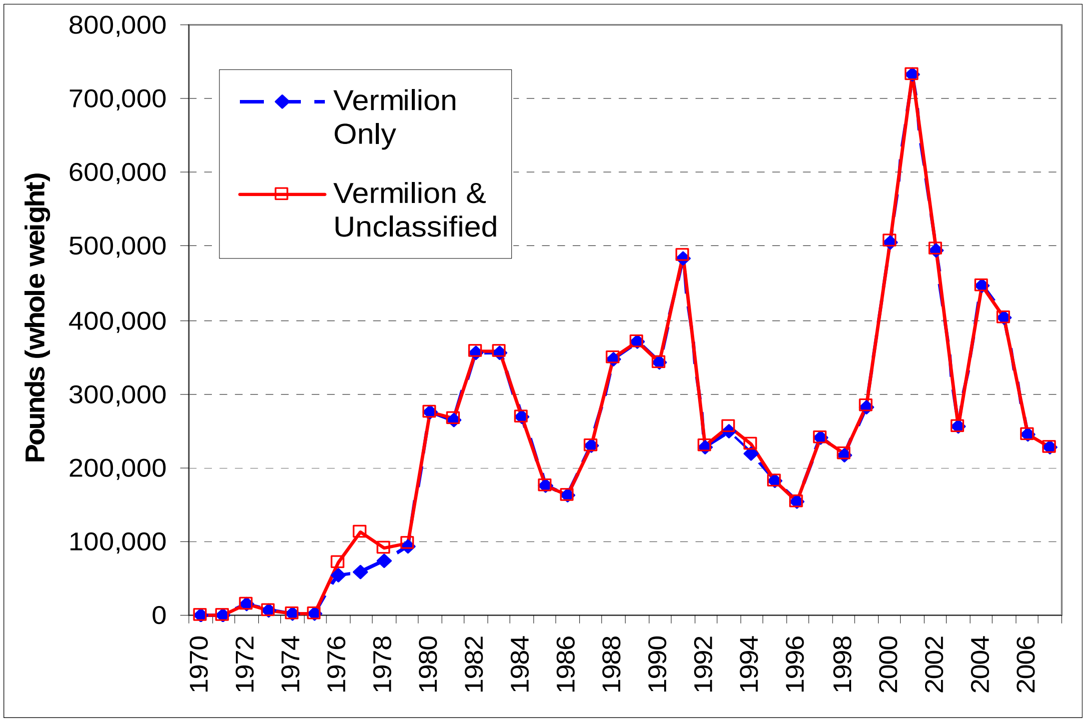


Figure 3.3. Comparison of South Carolina commercial landings for vermilion snapper with and without contribution from unclassified snappers.

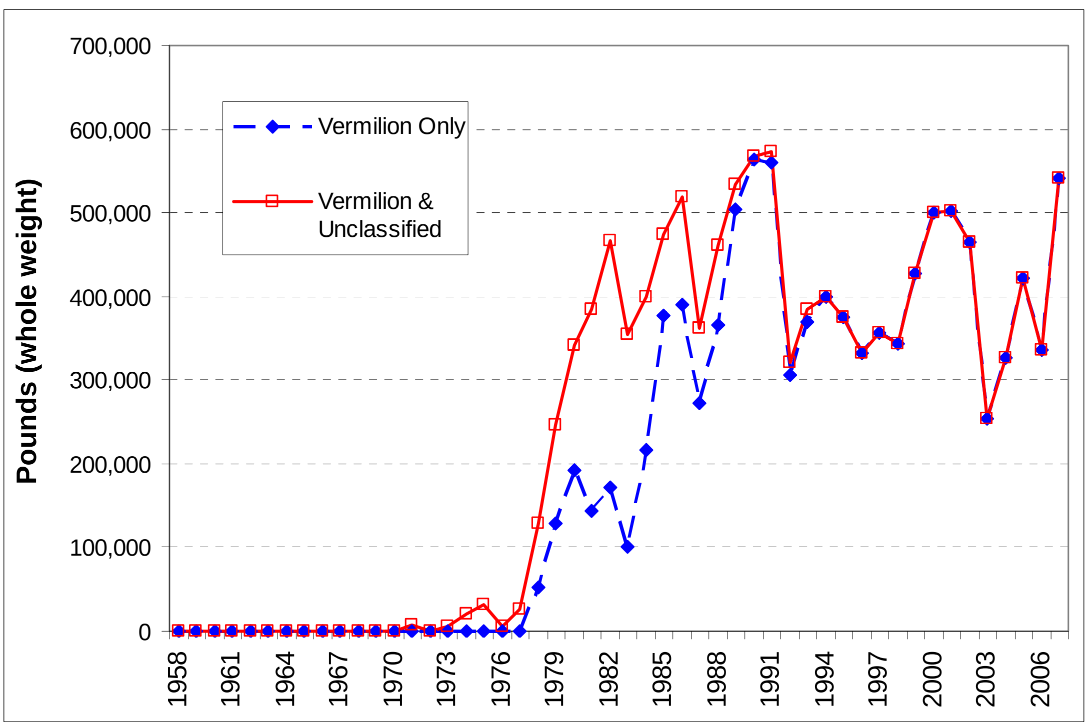


Figure 3.4. Comparison of North Carolina commercial landings for vermilion snapper with and without contribution from unclassified snappers.

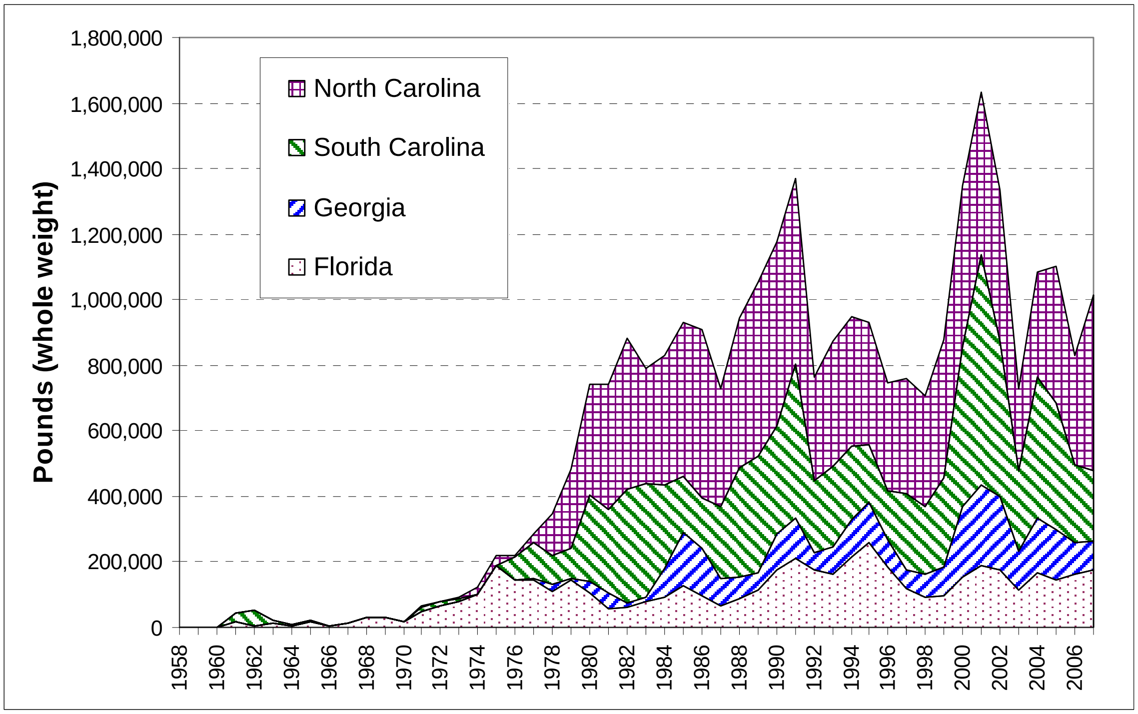


Figure 3.5. Vermilion snapper landings (pounds whole weight) by state from the U.S. South Atlantic, 1958-2007. (see text for data sources)

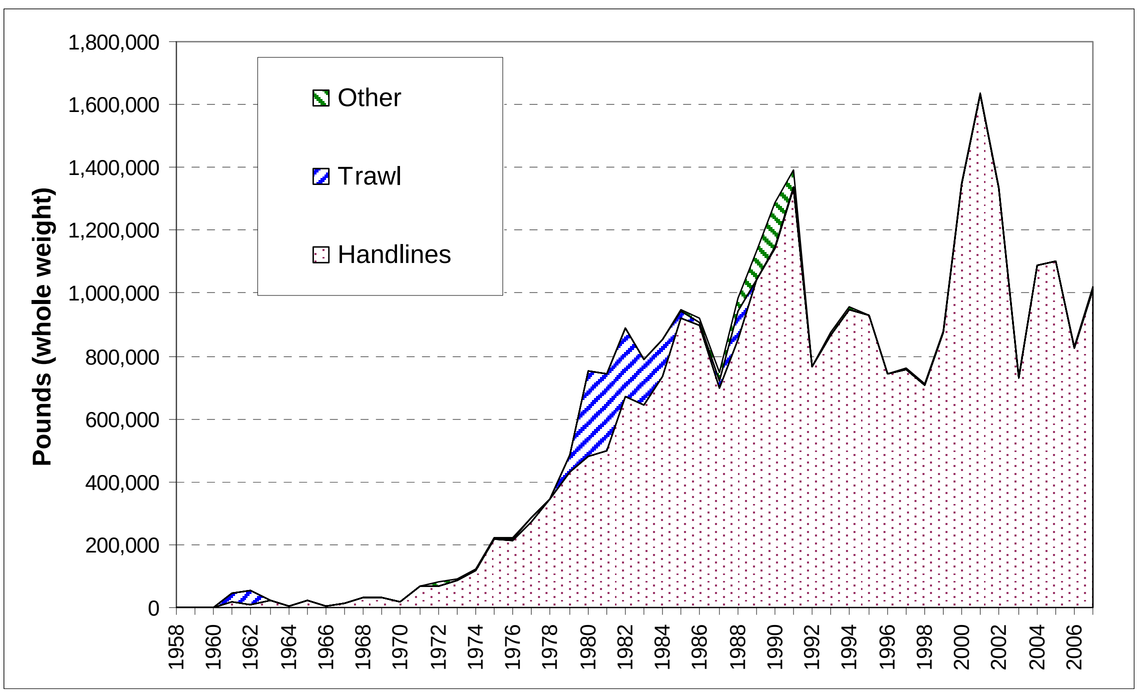


Figure 3.6. Vermilion snapper landings (pounds whole weight) by gear from the U.S. South Atlantic, 1958-2007. (see text for data sources).

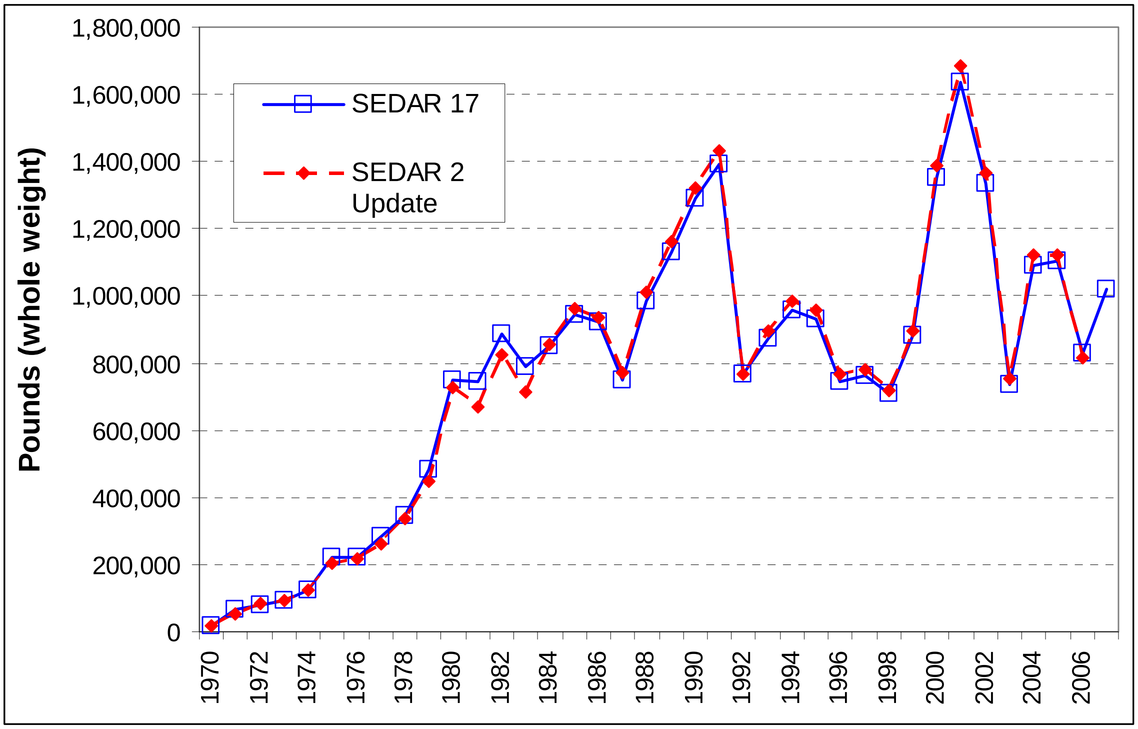


Figure 3.7. Vermilion snapper landings (pounds, whole weight) from the U.S. South Atlantic for 1970-2007, compared between the Update Assessment for SEDAR 2 and the current assessment (SEDAR 17).

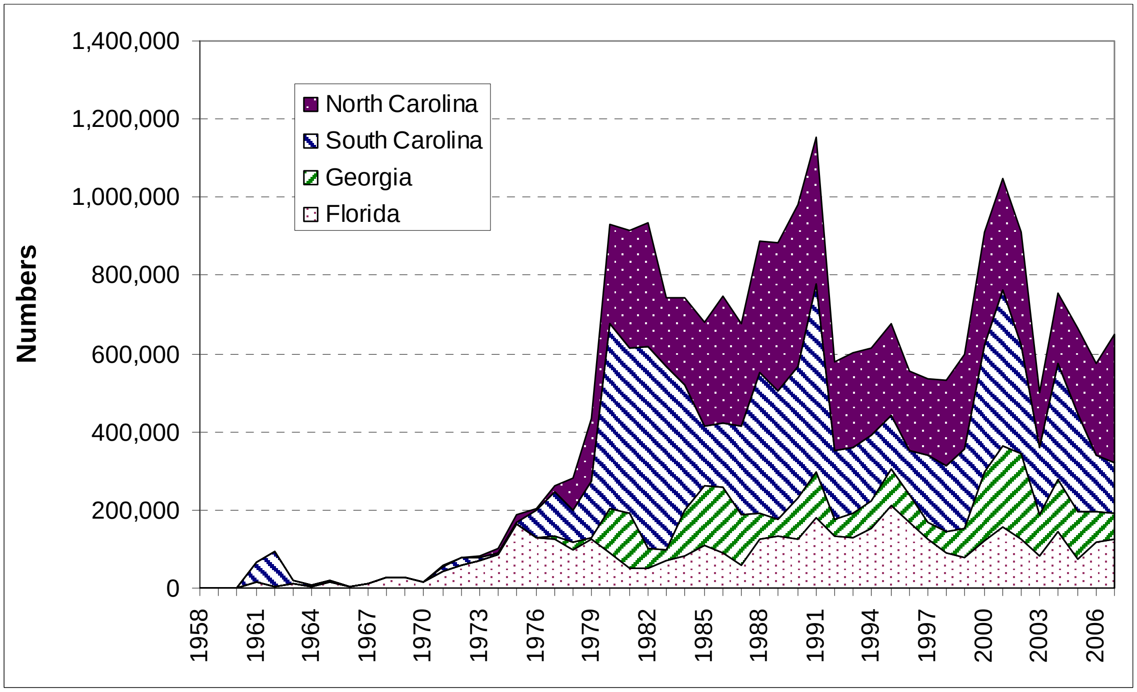


Figure 3.8. Vermilion snapper landings (number of fish) by state from the U.S. South Atlantic, 1958-2007. (see text for data sources)

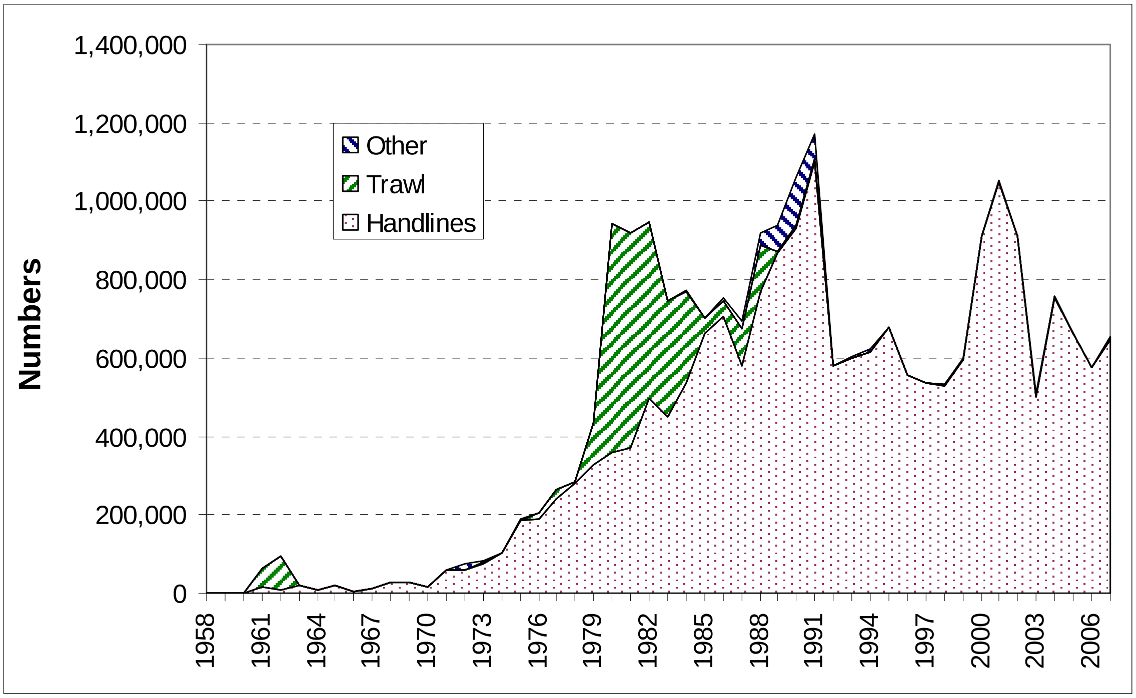


Figure 3.9. Vermilion snapper landings (number of fish) by gear from the U.S. South Atlantic, 1958-2007. (see text for data sources)

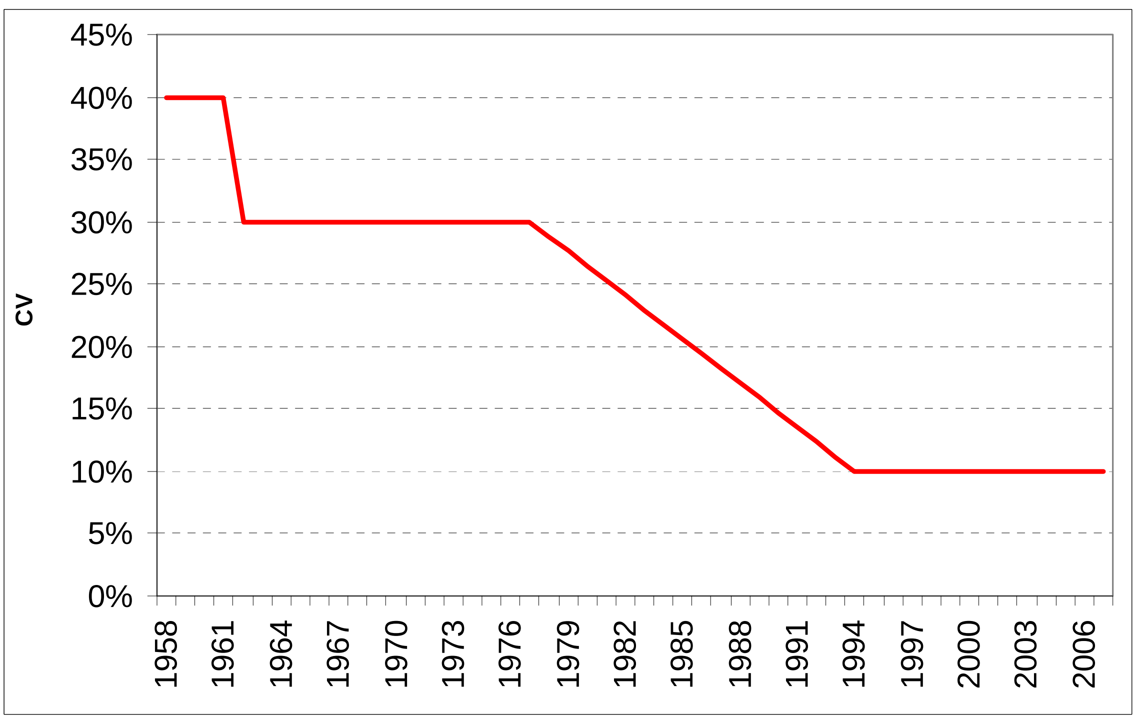


Figure 3.10. Coefficients of variation (CV) developed for reported commercial landings from 1958-2007 as developed by the Commercial Workgroup. The ALS was initiated in 1962, state-federal program began in late 1970s, and NC trip ticket began in 1994.

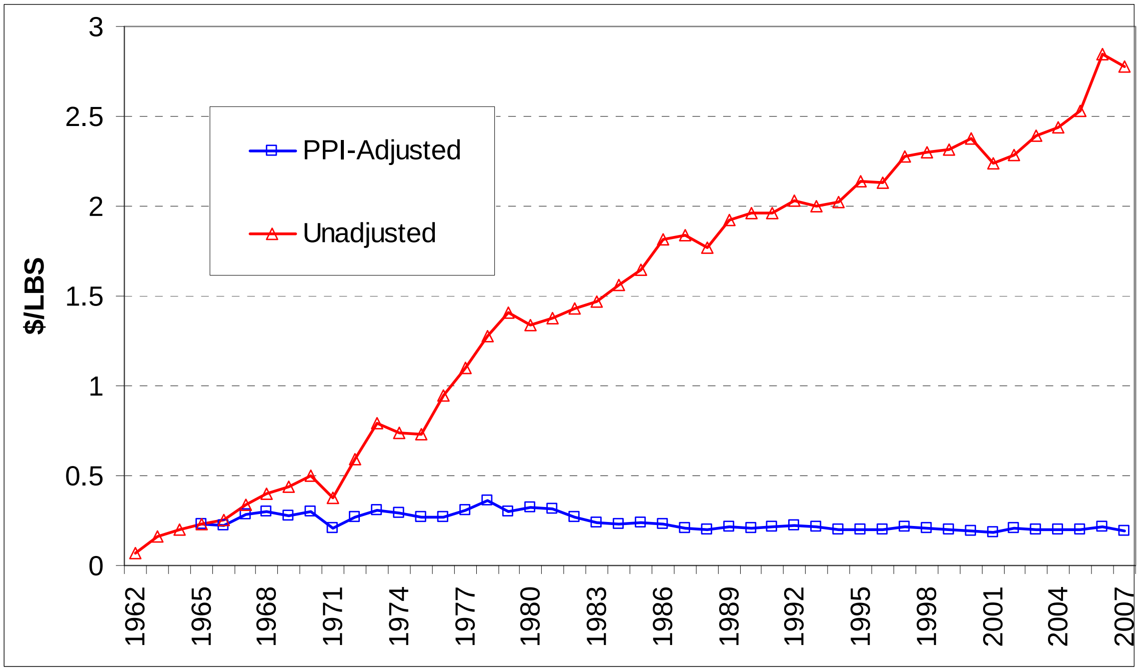


Figure 3.11. U.S. South Atlantic vermilion snapper, price per pound (whole weight), unadjusted and adjusted for inflation from the SEFSC ALS database, 1962-2007. Adjustment to price is by producer price index (PPI) using 1965 as base year.

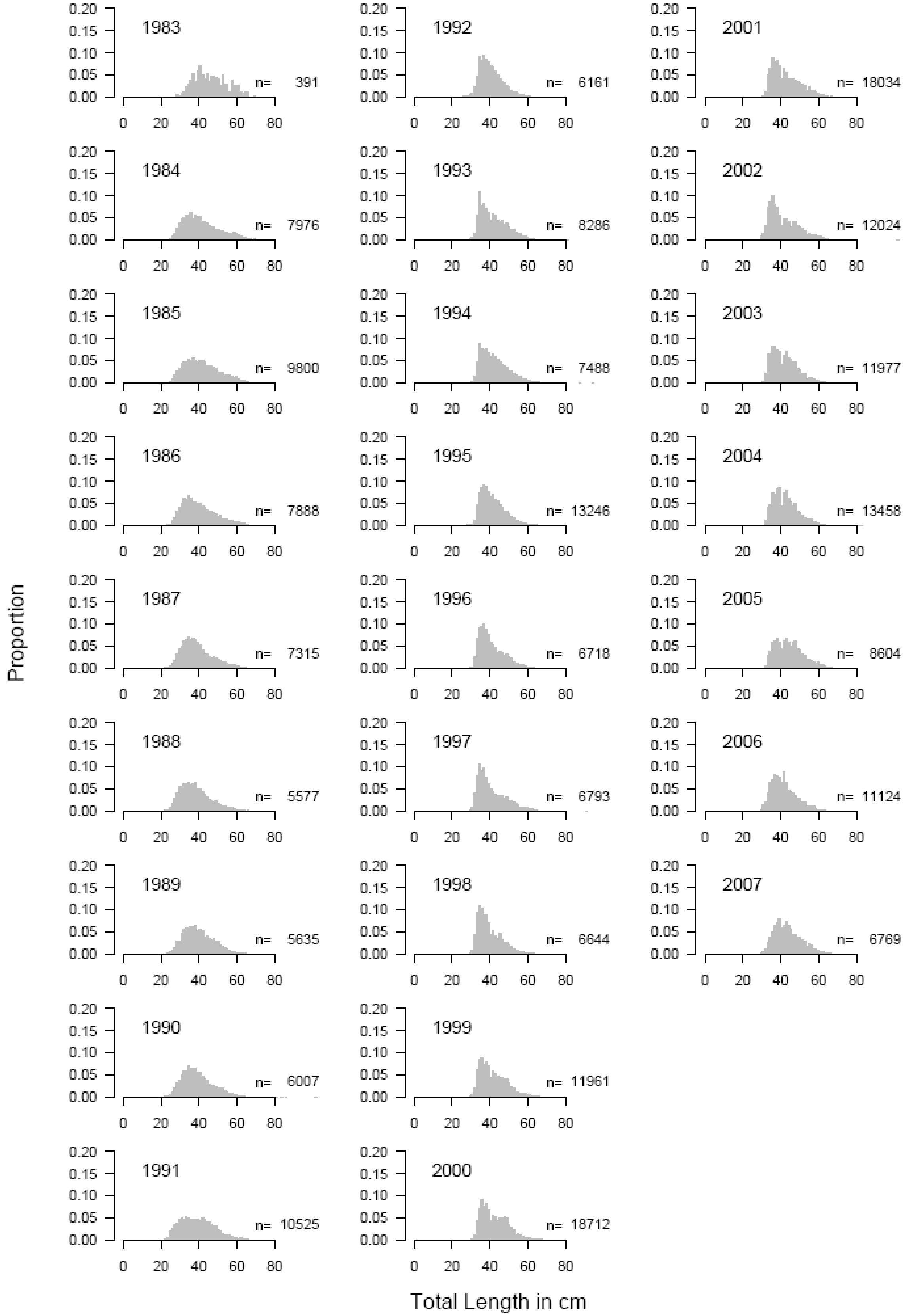


Figure 3.12. Vermilion snapper length frequencies (number at length, TL-cm) by year for commercial handline gear in the South Atlantic.

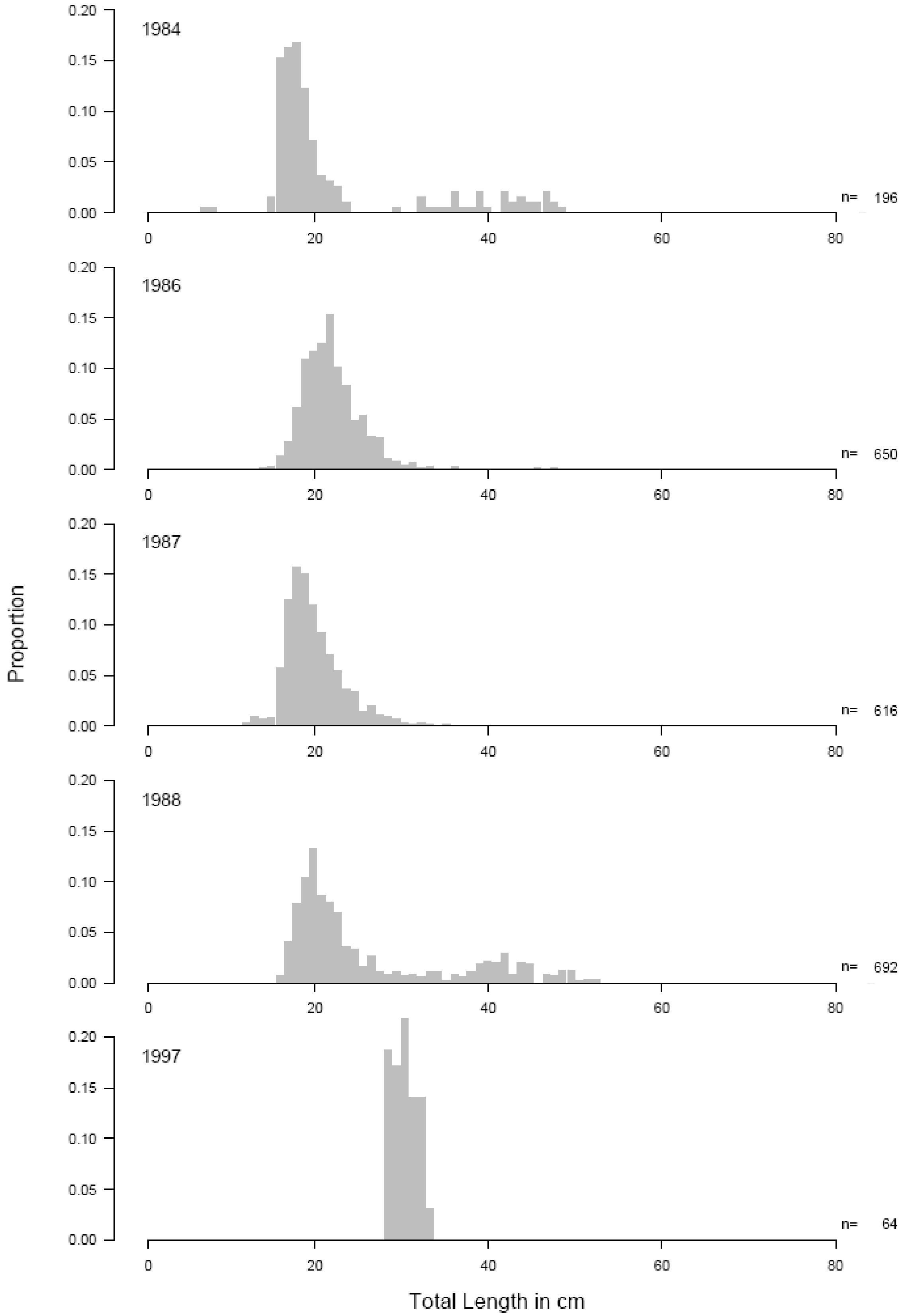


Figure 3.13. Vermilion snapper length frequencies (number at length, TL-cm) by year for commercial trawl gear in the South Atlantic.

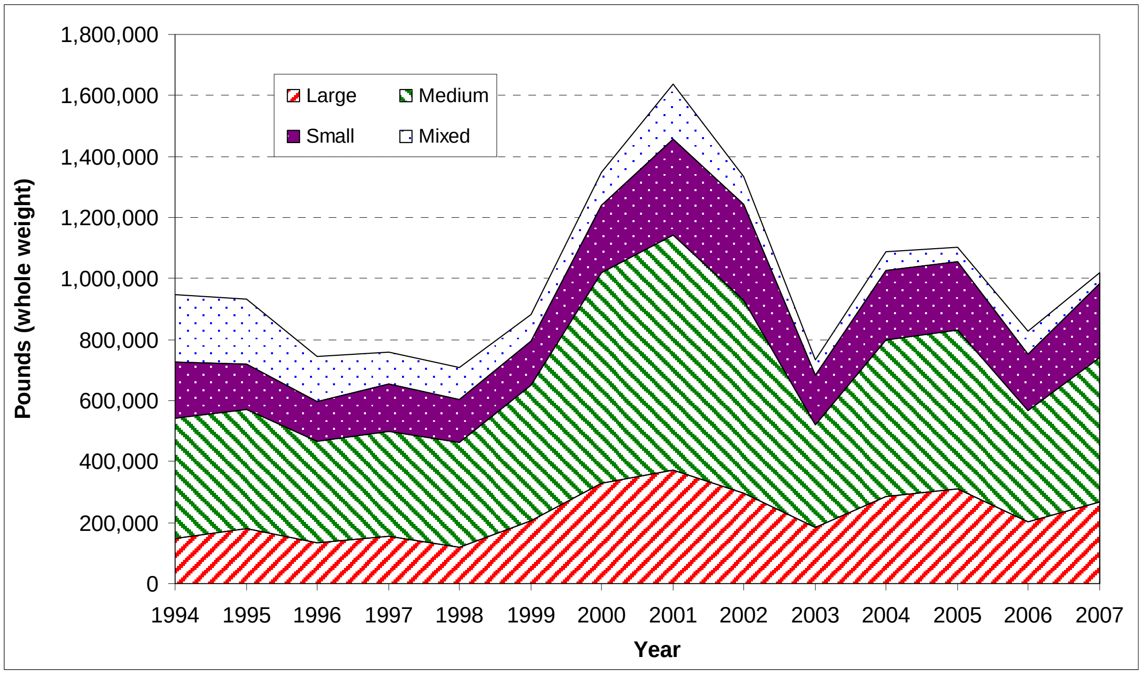


Figure 3.14. Commercial landings of vermilion snapper by market grade, 1994-2007.

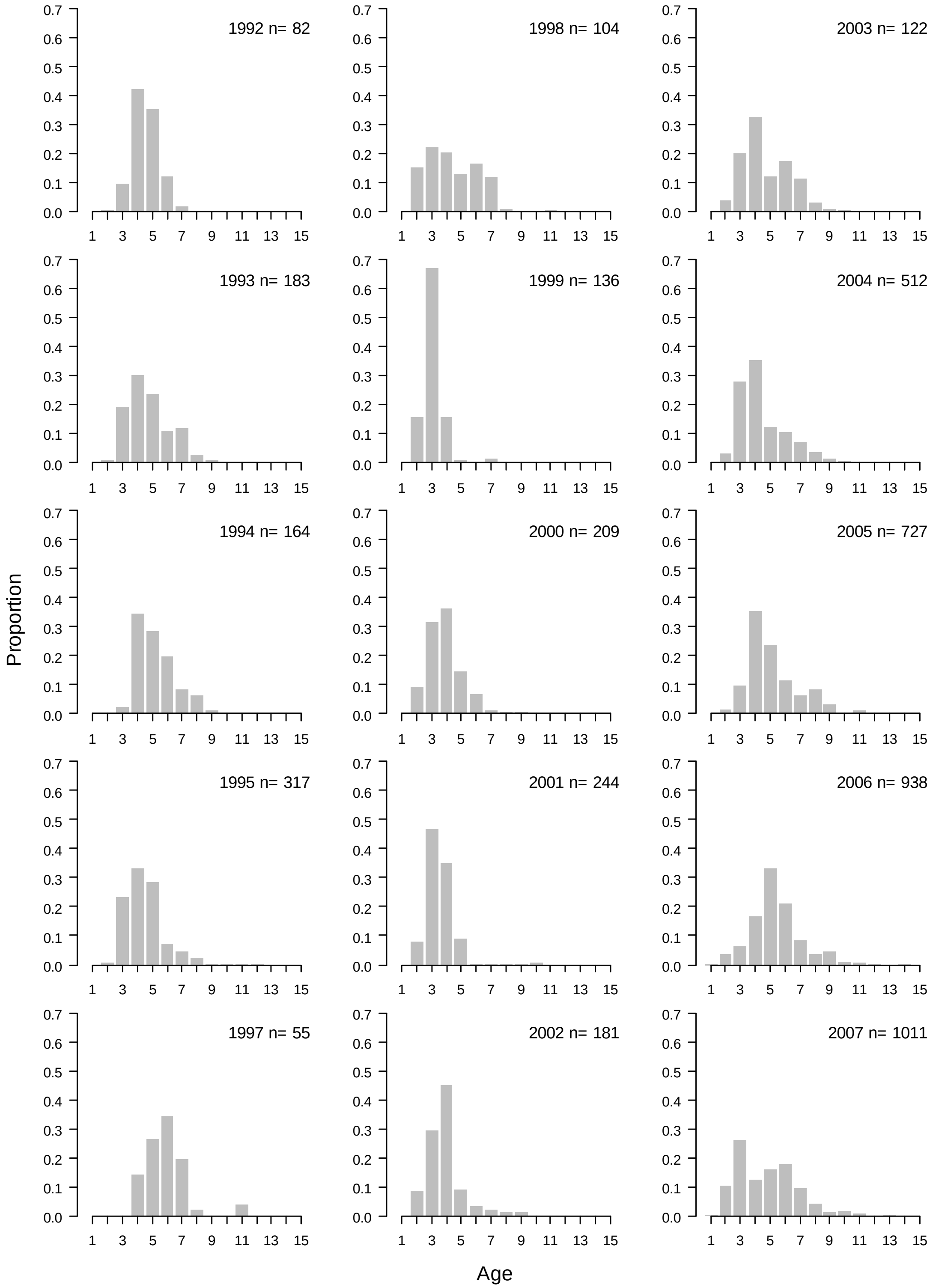


Figure 3.15. Vermilion snapper age frequencies by year for commercial handline gear in the South Atlantic.

Vermilion Snapper

4. Recreational Fishery Statistics

4.1 Overview - group membership, leader, and issues

Chair: Erik Williams (NMFS Beaufort); Members: Tom Sminkey (NMFS Silver Spring), Ken Brennan (NMFS Beaufort), Rob Cheshire (NMFS Beaufort), Beverly Sauls (FWRC).

Issues:

(1) Only one working paper for the recreational workgroup was submitted, reflecting the relatively small amount of pre-workshop work completed for this workgroup.

(2) At the time of the data workshop the 2007 headboat data had not been through a full set of quality assurance and quality control checks. Key entry was finalized just days prior to the DW.

(3) Historic data, does it accurately reflect catch levels of the species reported?

(4) Best use of at-sea headboat observer data.

(5) Use of Southeast Region Headboat Survey discard estimates.

4.2 Headboat Fishery

Historical accounts of headboat fishing in the South Atlantic for offshore snapper-grouper species date back to the years immediately following World War II. The headboat fishery is a readily identifiable segment of the recreational fishery, and is responsible for a significant percent of the recreational catch for some species, including vermilion snapper. Presently, the number of vessels in the headboat fleet fluctuates slightly from year to year as boats enter or leave the fishery, nonetheless, the relative size of the fleet is known, making it accessible to the Southeast Region Headboat Survey. The Southeast Region Headboat Survey included vessels only in North Carolina and South Carolina during the early part of the survey (1972-1975). The Survey expanded to northeast Florida in 1976, to southeast Florida in 1978, and finally to the Gulf of Mexico in 1986. From 1981-present the Survey included all headboats operating in the southeastern U.S. EEZ, encompassing the areas shown in Figure 4.9.1.

4.2.1 Headboat Landings

Vermilion snapper landings in numbers and weight were available from 1972 through the present from North Carolina and South Carolina. Landings from Georgia and the Atlantic coast of Florida, north of Cape Canaveral, were available starting in 1976, and are a major part of vermilion snapper headboat landings. Preliminary landings data were available for southeast Florida from 1978. Landings for 1976–1977 were estimated by regressing Georgia and north Florida observations against south Florida observations of landings in numbers and weight. Apparent errors in mean weights recorded for some months were corrected using the mean weights from adjacent months for the same area. Landings in numbers and weight are summarized by state (Table 4.8.1 and 4.8.2).

4.2.2 Headboat Discards

The logbook form was modified in 2004 to include a category to collect self-reported discards for each reported trip. This category is described on the form as the number of fish by species released alive and number released dead. Port agents instructed each captain on criteria for determining the condition of discarded fish. A fish is considered “released alive” if it is able to swim away on its own. If the fish floats off or is obviously dead or unable to swim, it is considered “released dead”. This self-reported data is currently unvalidated within the Headboat Survey. The recreational working group compared vermilion snapper discard data from the MRFSS At-Sea Observer program to the Headboat Survey logbook and determined that the logbook discard data was representative of the fishery (See SEDAR17-DW08).

4.2.3 Biological Sampling

Length and weight measurements from fishes taken by anglers on headboats are collected by port agents throughout the coverage area. Also, biological samples (scales, otoliths, spines, stomachs and gonads) are collected routinely. Length-weight data are used to compute average weights for each species and to compute age frequencies and mortality rates. This information combined with logbook data are used to calculate an estimate of total weight (kg) of reef fish landed in the headboat fishery.

4.2.3.1 Sampling Intensity Length/Age/Weight

The length composition from the headboat fishery was generated from 1972-2007. The sampling from 1972-1975 was in North Carolina and South Carolina. The Northern East coast of Florida was added for 1976-77. From 1978-2007 the sampling included all areas from NC to the Florida Keys (Table 4.8.3). Headboat at-sea observers collected length samples from 2003 to 2007 in North Carolina and South Carolina and in Florida from 2005-2007. The at-sea observer program collected length data on landed (Table 4.8.3) and discarded fish (Table 4.8.4).

4.2.3.2 Length – Age Distributions

The length composition from the headboat fishery was generated from 1972-2007. The DW participants recommend starting the series in 1976, the first year that the predominant fishing areas are fully covered. The 2003-2008 length distributions include the length data collected from the at-sea headboat observer program (See SEDAR 17-DW08). Values recorded in fork length were converted to total length using the conversion equation provided by the life history group. A length composition was generated for the landed and discarded fish from headboat survey. The headboat length composition associated with landings was weighted by the associated landings by region and period. The headboat areas were aggregated to regions of North Carolina, South Carolina, Georgia/North Florida, and South Florida (Florida break at Cape Canaveral). The periods consisted of January-May, June-August, and September –December. These periods were determined by the availability of monthly landings estimates from the early years of the headboat survey. The headboat length composition for discards was not weighted. Length composition values were stored in the VS_DW_summary.xls workbook and are plotted in Figure 4.9.2.

Lengths of discarded fish were collected by the MRFSS at-sea observer program from 2003 to 2007. Only North Carolina and South Carolina were sampled in 2003 and 2004. The 2005-2007 discard length data included all states from North Carolina to Florida (Table 4.8.4). Length composition values of headboat discards were stored in the VS_DW_summary.xls workbook and are plotted (Figure 4.9.3).

The headboat age samples were collected in Florida throughout the time series with high variability in sample size among years. Ages from North Carolina and South Carolina were available during the early 1990s and in years since about 2002. No samples were obtained from Georgia except in 2006 and 2007 where a few ages were obtained (Table 4.8.5). The headboat ages were weighted by the headboat length composition to overcome potential bias in selecting fish to age and to transfer the weighting given to the length composition based on landings to the age composition. The weighting value for each age record was the proportion from the length composition corresponding to the year and length (1 cm bins) of the aged fish. The weighting values were then summed by age and year to determine the age composition of the fishery. Each value was normalized to sum to 1 across years by dividing each value by the sum for that year. Headboat age composition values were stored in the VS_DW_summary.xls workbook and are plotted in Figure 4.9.4.

4.2.3.3 Adequacy for Characterizing Catch

Catch and effort data are reported on logbooks provided to all headboats in the Survey. These forms are completed by the captain or designated crew member after each trip and represent the total number and weight of all the species kept, along with the total number of fish discarded for each species. Each month port agents collect these logbook trip reports and check for accuracy and completeness. Although reporting via the logbooks is mandatory, compliance is low in some areas for recent years, especially South Florida. Landings for these non-reporting vessels were estimated from similar vessels adjusted using port sampler intercept data and estimates of the number of anglers.

4.2.3.4 Alternatives for Characterizing Discards

Based on the comparison of logbook data to the At-Sea Observer data, it was concluded that the logbook discard estimates for vermilion snapper would be used for the available years back to 2004 for the South Atlantic headboat fishery. For years prior to the addition of the discard category on the logbook form, the recreational workgroup suggests using the average for 2004-2006 to interpolate discards back to 1999 when the size limit was increased from 10" to 11". Further, the group recommends using the charter mode to calculate headboat discards for 1972-1998, since the discard rates from the longer time series of MRFSS reflect historic changes in discard rates. These rates include the impacts from changes in recreational size limits and bag limits for vermilion snapper over time.

4.2.4 Headboat Catch-at-Age/Length

Catch-at-age or length was not computed since age/length composition data is handled separately from catch estimates. For years in which adequate age/length sampling occurs, one could infer catch-at-age/length by multiplying the annual catch estimate by the annual age/length composition.

4.2.5 Headboat Effort

Headboat effort has changed only slightly in the past 10 years throughout the South Atlantic (Fig.4.9.5). The number of estimated trips in the headboat fishery has remained relatively constant during this period, with the only noticeable change occurring as effort peaked in GA and FL in 2000.

4.2.6 Comments on Adequacy of Headboat Data for Assessment Analyses

Catch and effort data are reported on logbooks provided to all headboats in the Survey. These forms are completed by the captain or designated crew member after each trip and represent the total number and weight of all the species kept, along with the total number of fish discarded for each species. Each month port agents collect these logbook trip reports and check for accuracy and completeness. Although reporting via the logbooks is mandatory, compliance is low in some areas for recent years, especially South Florida. No other data sources were available to provide information on the headboat fishery sector.

4.3 General Recreational Fishery (aka MRFSS)

4.3.1 General Recreational Landings

The report, SEDAR16-DW-21: Recreational Survey Data for King Mackerel in the Atlantic and Gulf of Mexico**,** was presented at the recent King Mackerel Data Workshop (Feb. 2008) and describes the methodology used to produce the recreational catch estimates based on the traditional MRFSS, the Charter Boat estimates produced by the For-Hire Survey method (FHS) from 2004-2007, and the ‘normalization’ of the pre-FHS estimates of Charter Boat effort and inclusion in the total annual landings estimates. Correction factors to adjust historical estimates in the Atlantic to those which would have been expected had the new methodology been used were not available prior to that meeting. This computational normalization was only modeled for the southeast states, NC to FL, and followed a similar method used in the Gulf of Mexico by Diaz and Phares (2006). Vermilion snapper was included in the southeast analyses and time-series of adjusted landings. It was determined that these statistics provided the best available estimates of recreational landings.

The fishing year for vermilion snapper in the southeast was the calendar year, and the range included in the landings was the southeast sub-region only (NC to Dade-Miami County on east coast of FL).

4.3.1.1 Historical Recreational Landings

The workgroup was tasked with collecting any and all recreational landings for years prior to the start of modern data collections. Catch estimates from the MRFSS are not available from pre-1981, and for headboat logbook estimates, vermilion snapper landings are not available pre-1972 from North Carolina to South Carolina, and pre-1980 for Georgia through Florida.

The workgroup considered several historic data sets. The U.S. Fish and Wildlife Service conducted salt-water angling surveys in 1960, 1965, and 1970 (Clark 1962; Deuel and Clark 1968; Deuel 1973). These surveys resulted in estimates of the number of anglers and the number and weight of fish caught by region for all recreational fishing, including headboats. The South Atlantic region was used for this assessment. In these surveys vermilion snapper are not reported at the species level, instead an unclassified snapper category is listed. Along with a snapper category in 1960, yellowtail snapper are reported separately, while in 1965 and 1970 both yellowtail snapper and red snapper are reported separately (Table 4.8.6).

Other data sources examined corroborate the estimates from the 1960, 1965, and 1970 salt-water angling surveys. Older reports from the state of Florida suggest the number of anglers estimated in these salt-water angling surveys is not too different (Ellis et al. 1958). Ellis et al. (1958) estimated 1,247,000 total number of salt and brackish water anglers in Florida in 1955, while the 1960 salt-water angling survey estimated 1,024,000 total anglers for the whole U.S. South Atlantic. Considering the Ellis et al. (1958) estimate includes the west coast of Florida, while the 1960 survey includes Georgia, South Carolina, and North Carolina, these estimates are not too different.

In order to estimate vermilion snapper landings from the snapper category in these surveys we analyzed recent catches of vermilion snapper in the headboat and general recreational fisheries. In the earliest years the ratio of headboat landings to all recreational landings (headboat plus general recreational) of vermilion snapper is high (Figure 4.9.6). The linear trend in this proportion suggests that the headboat fishery probably accounted for more than 95% of the historic recreational vermilion snapper landings. This high proportion fits with vermilion snapper being primarily an offshore fish species. The next step in breaking out the unclassified snapper category is to analyze the proportion of vermilion snapper relative to other snappers in the headboat fishery (Figure 4.9.7). We analyzed both the proportion of vermilion to all snappers minus yellowtail and the proportion of vermilion to all snappers minus yellowtail and red snapper.

The snapper data from the salt-water angling surveys for 1960 did not match the other years and therefore it was handled differently. For 1960 we chose to combine the unclassified snapper and yellowtail snapper estimates into an all snapper category; then applied the proportions for categories from the 1965 and 1970 surveys. This resulted in estimates for unclassified snappers, yellowtail snapper, and red snapper of 623, 11005, and 1036 (thousands), respectively. Applying the proportion of 0.75 vermilion to unclassified (minus yellowtail and red) from the headboat fishery yielded the final vermilion snapper estimates in Table 4.8.7.

The percent standard error (PSE) estimates in Table 4.8.7 were derived from a linear interpolation of tabled values provided in the U.S. Fish and Wildlife Service salt-water angling survey reports (Clark 1962; Deuel and Clark 1968; Deuel 1973). These PSE’s are likely an underestimate of the true variance, since the vermilion snapper numbers were derived using a ratio of snappers, which itself has an unknown level of uncertainty not captured in the PSE values listed in Table 4.8.7.

4.3.2 General Recreational Discards

The access-point recreational fisheries surveys (angler intercept) ask anglers about any fish that were not landed or were landed, but not in the whole condition. Those fish that were not landed and were released alive were designated as discards and the raw reported data were expanded to the estimated totals following the same procedures as the landed fish (see landings & discards worksheet). No size data were available for this class of catch (except for those headboat-caught fish on trips with an observer/interviewer on board - these are included in the headboat mode section) so catches of discards are reported by number only.

4.3.3 Biological Sampling

The only biological data collected during the routine MRFSS/FHS surveys are length of fish and weight of landed fish. Both are collected opportunistically but field interviewers are instructed to measure and weigh up to fifteen fish of each available species from each angler interviewed. The individual fish are to be selected from the total landed catch at random to avoid any size-bias in the resultant sample. Fish are measured to the nearest mm fork length (center-line total length in non-forked fish) and weighed to the nearest 1/8 or ½ kg, depending on scale precision. Annual sample sizes of fish measured are included on the length-frequency worksheet. The worksheet required that vermilion snapper lengths be expressed in total length (TL) so the fork lengths (FL) obtained from the field were converted to TL using this equation (provided by the life history workgroup): $TL = 1.436 + 1.106*(FL)$ and converting to cm.

4.3.3.1 Sampling Intensity Length/Age/Weight

See length frequency sample sizes on annual length-frequency worksheet.

4.3.3.2 Length – Age Distributions

The general recreational age composition was created using data from charter vessels and private vessels. The sampling was primarily from the charter vessel mode in Florida (See Tables 4.8.8 and 4.8.9). The recreational ages were weighted by the recreational length composition to overcome potential bias in selecting fish to age and to transfer the weighting given to the length composition based on landings to the age composition. The weighting value for each age record was the proportion from the length composition corresponding to the year and length (1 cm bins) of the aged fish. The weighting values were then summed by age and year to determine the age composition of the fishery. Each value was normalized to sum to 1 across years by dividing each value by the sum for that year. General recreational length and age composition values were stored in the VS_DW_summary.xls workbook and are plotted in Figures 4.9.8 and 4.9.9, respectively.

4.3.3.3 Adequacy for Characterizing Catch

Not addressed.

4.3.3.4 Alternatives for Characterizing Discards

Not addressed.

4.3.4 General Recreational Catch-at-Age/Length

Catch-at-age or length was not computed since age/length composition data is handled separately from catch estimates. For years in which adequate age/length sampling occurs, one could infer catch-at-age/length by multiplying the annual catch estimate by the annual age/length composition.

4.3.5 General Recreational Effort

Not addressed.

4.3.6 Comments on Adequacy of General Recreational Data for Assessment Analyses

Not addressed.

4.4 Recreational Workgroup Research Recommendations

There was insufficient time for this topic to be addressed by the workgroup during the data workshop.

4.5 Tasks for Completion following Data Workshop

Recreational workgroup things to be done post-DW:
(1) MRFSS landings for vermilion and Spanish from 1981-1985 (Tom Sminkey)
(2) Dig through some archives for more information on historic catch rates of Spanish mackerel (Beverly Sauls and Ken Brennan)
(3) Produce PSE's for historic and other landings time series (Erik Williams)
(4) Compute pre-2004 discards in headboat fishery from ratio of charter mode in MRFSS (Ken Brennan)
(5) Compile length composition data from headboat and MRFSS (Rob Cheshire)
(6) Submit all finalized data to Rob by June 13th (All)

4.8 Literature Cited

Clark, J.R. 1962. The 1960 Salt-Water Angling Survey. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Circular 153, 36 pp.

Deuel, D.G. 1973. The 1970 Salt-Water Angling Survey. U.S. Department of Commerce, National Marine Fisheries Service, Current Fishery Statistics No. 6200, 54 pp.

Deuel, D.G. and J.R. Clark. 1968. The 1965 Salt-Water Angling Survey. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Resource Publication 67, 51 pp.

Ellis, R.W., A. Rosen, and A.W. Moffett. 1958. A survey of the number of anglers and of their effort and expenditures in the coastal recreational fishery of Florida. State of Florida, Board of Conservation, Technical Series No. 24, 50 pp.

4.8 Tables

Table 4.8.1. Total number of vermilion snapper landed by state In the South Atlantic headboat fishery 1981-2007

Year	NC	SC	GA\NEFL	SEFL	Grand Total
1981	37829	25638	171029	36491	270987
1982	66210	104075	159093	32943	362321
1983	50194	73285	192548	83013	399040
1984	31146	60353	190516	42414	324429
1985	43907	106273	284923	94700	529803
1986	53796	114206	283153	81946	533101
1987	41904	176757	330108	182238	731007
1988	53807	169034	366423	151627	740891
1989	48541	140114	284303	188293	661251
1990	123396	167102	231284	134077	655859
1991	159682	174055	200209	66555	600501
1992	105240	147838	32112	60076	345266
1993	86532	171996	28722	39777	327027
1994	98288	216215	24549	30668	369720
1995	102328	199748	19386	33304	354766
1996	87806	198287	15481	38766	340340
1997	103135	218335	23309	19963	364742
1998	76576	210360	37375	17252	341563
1999	87368	213584	66945	14039	381936
2000	102653	207754	96240	21588	428235
2001	99609	195820	85421	38026	418876
2002	71370	154375	74893	34905	335543
2003	43295	114342	63643	30516	251796
2004	62042	143322	73902	49815	329081
2005	92257	101284	66101	15808	275450
2006	88192	166639	81529	8364	344724
2007	104710	323099	76126	4035	507970
Grand Total	2121813	4293890	3559323	1551199	11526225

Table 4.8.2. Total pounds of vermilion snapper landed by state in the South Atlantic headboat fishery 1981-2007

Year	NC	SC	GA\NEFL	SEFL	Grand Total
1981	81367	35071	85488	28059	229984
1982	123943	89066	97716	29115	339840
1983	93368	59097	96225	46694	295385
1984	47387	47944	121258	28375	244964
1985	53764	98190	156360	63853	372168
1986	55031	93358	145767	55159	349315
1987	39025	134761	154955	123200	451941
1988	46433	131111	150128	90965	418638
1989	41137	91577	105393	108433	346539
1990	108164	109316	81438	87856	386774
1991	128149	109386	65784	29985	333303
1992	95828	105671	20593	27505	249597
1993	73549	138415	16758	28478	257200
1994	92947	154310	13914	20477	281647
1995	92286	146054	10776	22743	271859
1996	77650	158325	10038	30295	276308
1997	85591	187511	15196	11615	299912
1998	70050	170842	23359	11240	275492
1999	86975	191435	46493	10830	335732
2000	102668	225250	64681	14188	406785
2001	109674	194077	73862	25007	402620
2002	82365	160671	59469	23941	326447
2003	59937	135208	57044	35255	287444
2004	96470	175888	54798	34406	361562
2005	111582	133264	56619	10512	311977
2006	128547	195696	71091	7017	402351
2007	138038	405324	67177	3225	613765
Grand Total	2321925	3876817	1922380	1008428	9129550

Table 4.8.3. Sample size of vermilion snapper measured for length in the headboat program. NC=North Carolina, SC=South Carolina, NF=Georgia/North Florida to Cape Canaveral, SF=South Florida from Cape Canaveral through the Florida Keys.

Year	NC	SC	NF	SF	Total
1972	796	344			1140
1973	329	251			580
1974	528	723			1251
1975	689	608			1297
1976	451	293	402		1146
1977	145	218	673		1036
1978	204	220	884	460	1768
1979	271	52	901	165	1389
1980	323	171	602	252	1348
1981	174	137	854	170	1335
1982	587	686	1334	170	2777
1983	863	587	1574	1458	4482
1984	543	1516	1918	568	4545
1985	818	627	3012	1437	5894
1986	1158	693	3213	1095	6159
1987	1262	1023	3106	936	6327
1988	1307	731	2193	528	4759
1989	993	925	2191	659	4768
1990	873	1222	2832	381	5308
1991	1065	944	1847	173	4029
1992	610	1752	301	160	2823
1993	649	2086	365	223	3323
1994	659	4121	417	527	5724
1995	736	3719	215	129	4799
1996	760	2736	300	62	3858
1997	843	2656	460	174	4133
1998	515	2478	899	347	4239
1999	1012	1665	1402	227	4306
2000	1373	1669	1229	198	4469
2001	1474		1531	382	3387
2002	496	492	2416	491	3895
2003	442	1108	1732	542	3824
2004	579	366	1315	1064	3324
2005	515	123	947	621	2206
2006	547	975	1151	536	3209
2007	642	1195	1049	1109	3995

Table 4.8.4. Sample size of length data from the headboat sector vermilion snapper discards.

Year	NC	SC	FL	Total
2003	23			23
2004	90	86		176
2005	202	191	259	652
2006	180	20	314	514
2007	55	43	755	853

Table 4.8.5. Sample size of vermilion snapper headboat age data by state.

Year	NC	SC	GA	FL
1975		1		
1980		1		11
1981				112
1982				38
1983				2
1986				89
1987	1			7
1988				2
1991	136	20		10
1992	41	5		
1993	42	5		1
1994	116	135		1
1995	50	24		117
1996	6	11		56
1997	7	1		6
1998				2
2001				22
2002				10
2003	29	7		67
2004	29	3		298
2005	155	1		329
2006	51	51	8	487
2007	173	53	5	490

Table 4.8.6. Estimates of the number of snapper caught (1000s) in the recreational fisheries in the U.S. South Atlantic from the U.S. Fish and Wildlife Service salt-water angling surveys conducted in 1960, 1965, and 1970.

Category	**1960**	**1965**	**1970**
Unclassified snapper	9,433	1,116	613
Yellowtail snapper	3,231	19,686	10,843
Red snapper		598	1,797

Table 4.8.7. Final estimates of vermilion snapper from recreational anglers.

Year	**Landings (1000s)**	**PSE**
1960	467	65%
1965	837	82%
1970	460	114%

Table 4.8.8. Sample size from vermilion snapper age data from each of the fishing modes (CB=charter, and PR=private).

Year	CB	PR	Total
2001	83		83
2002	217		217
2003	363	5	368
2004	102		102
2005	296	3	299
2006	228	2	230
2007	31		31

Table 4.8.9. Sample size of aged vermilion snapper by state from the general recreational sector.

Year	NC	FL	Total
2001		83	83
2002		217	217
2003	34	334	368
2004		102	102
2005		299	299
2006		230	230
2007		31	31

4.9 Figures

Figure 4.9.1. Reporting areas used in the Southeast Region Headboat Survey.

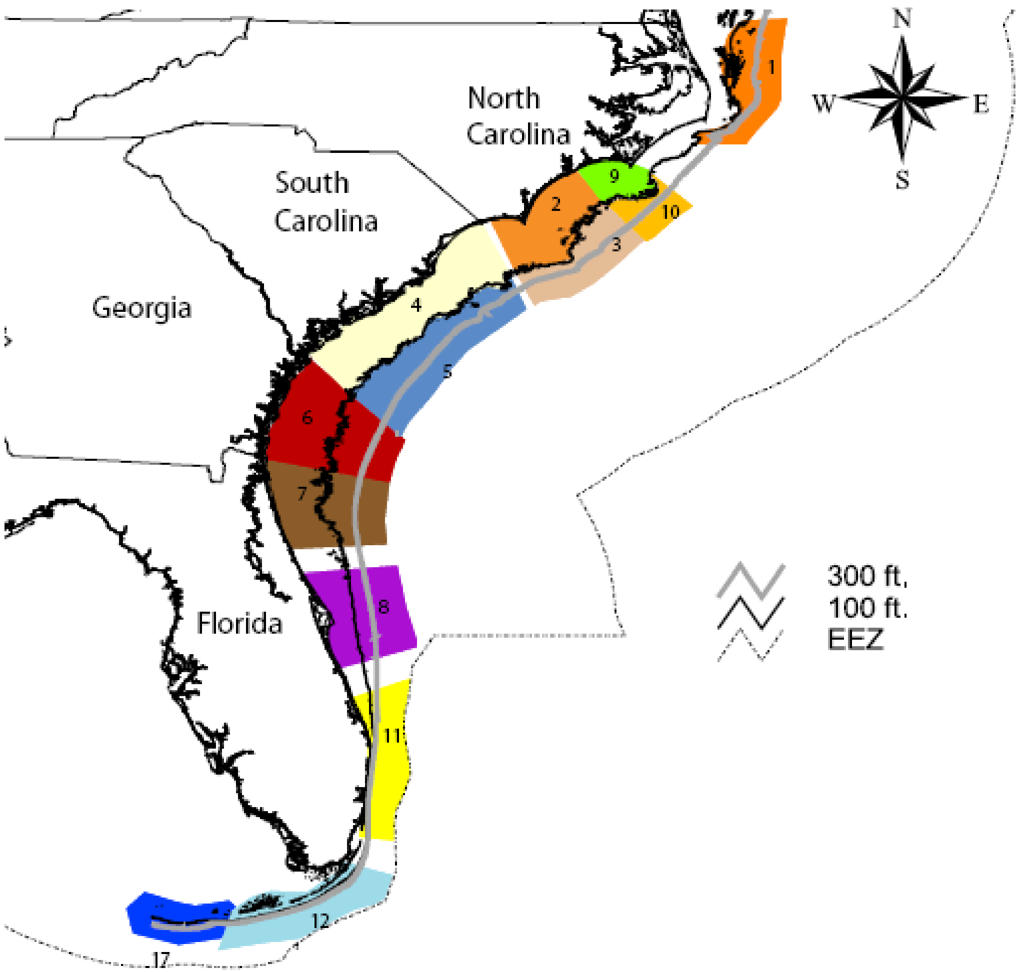


Figure 4.9.2. Vermilion snapper length composition from the headboat survey, data in 1 cm bins, total length. The dashed line represents the 1992 10 inch size limit, solid line represents the 1999 11 inch size limit and the dotted line represents the 2007 12 inch size limit.

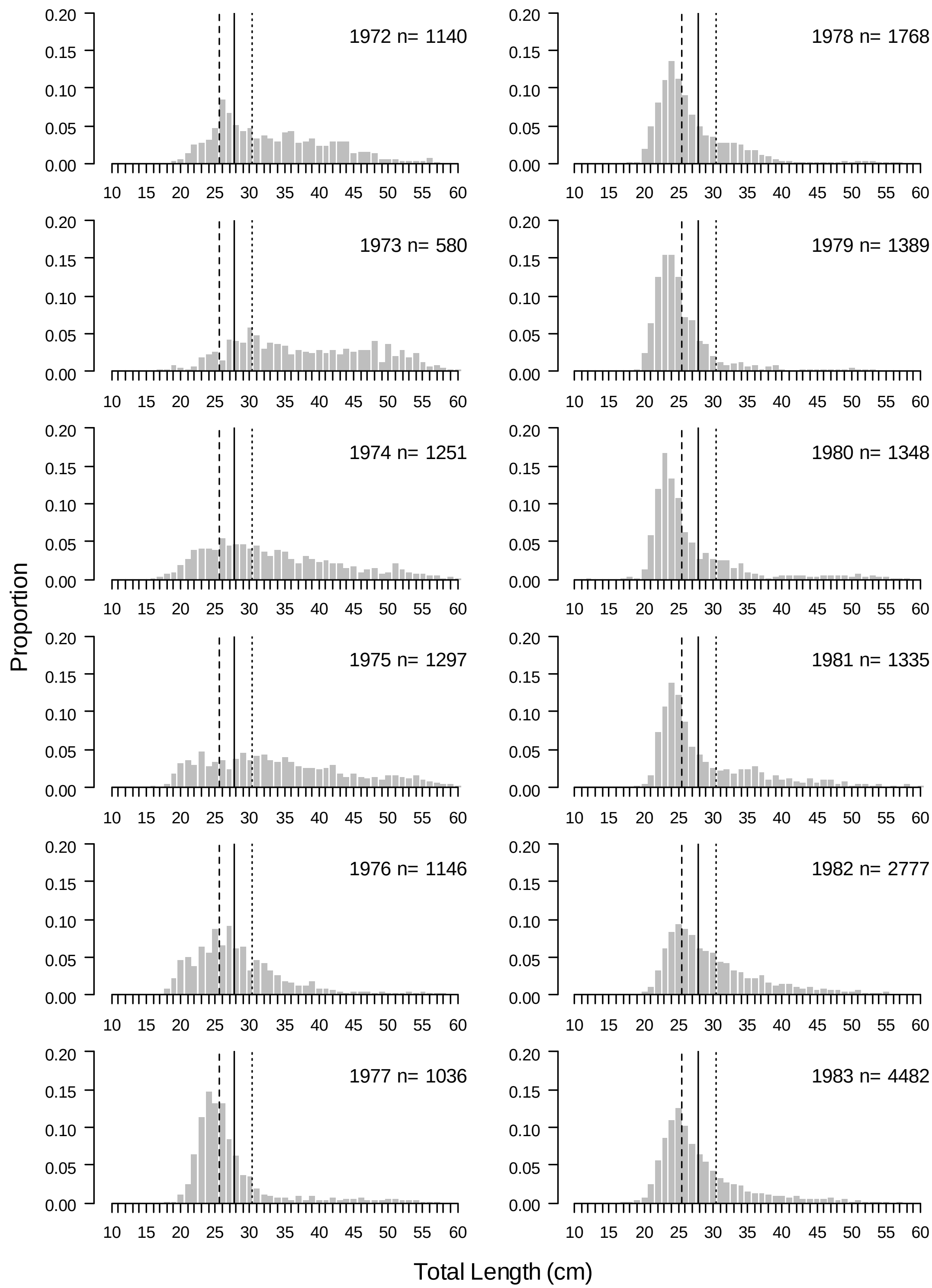


Figure 4.9.2. continued.

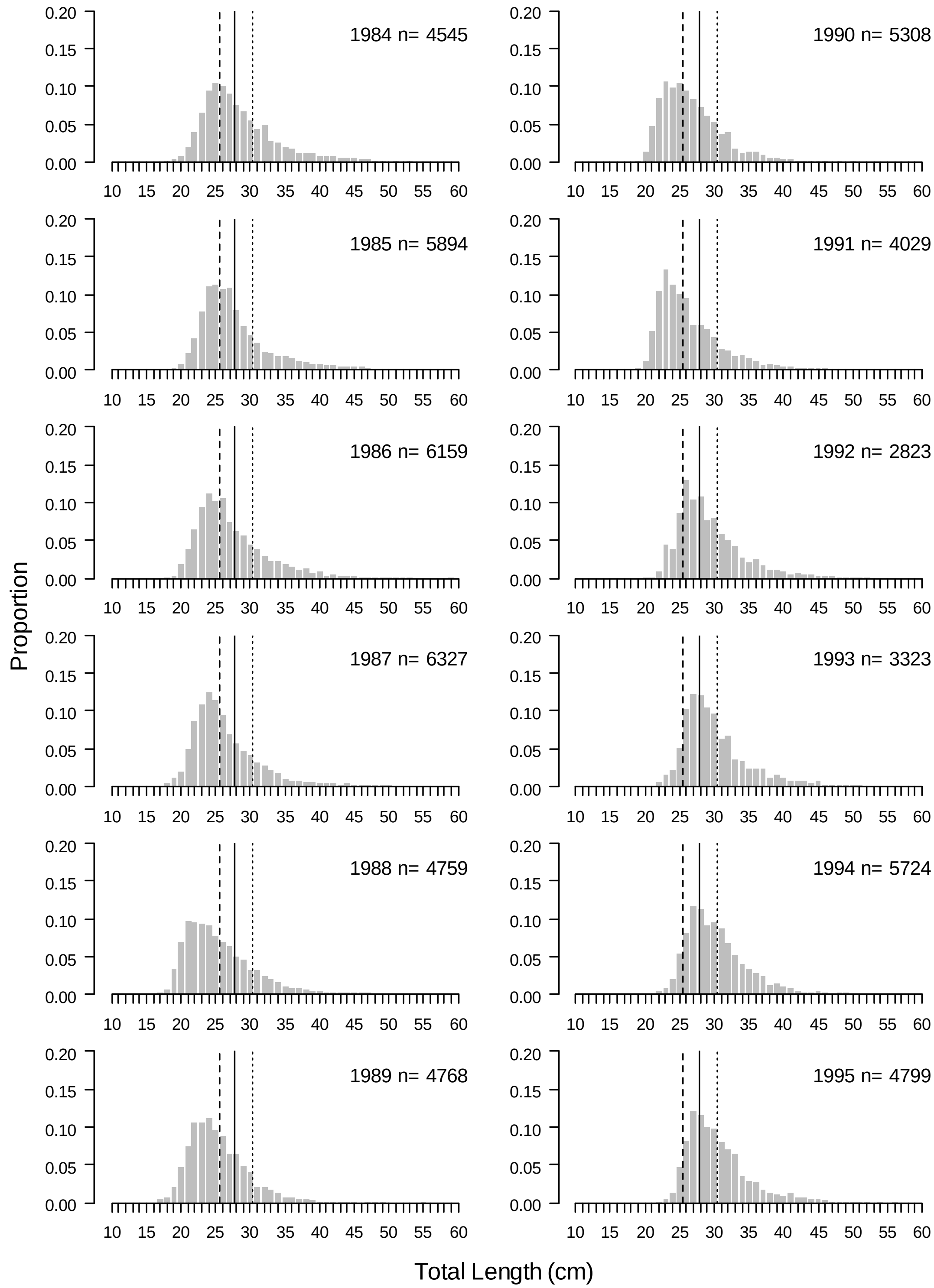


Figure 4.9.2. continued.

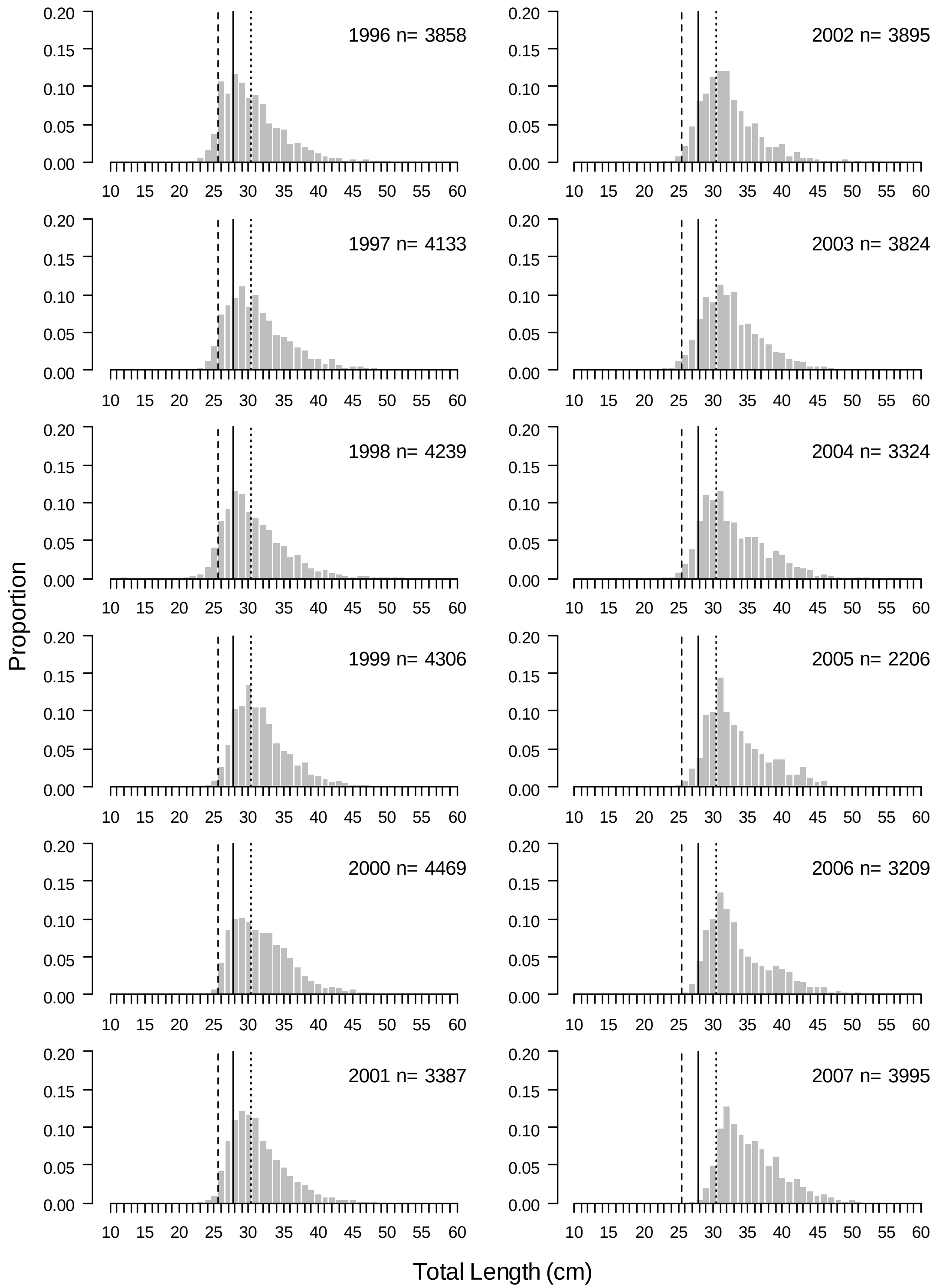


Figure 4.9.3. Vermilion snapper discard length composition from the headboat sector collected by the MRFSS headboat observer study. The, solid line represents the 1999 11 inch size limit and the dotted line represents the 2007 (Oct. 2006) 12 inch size limit.

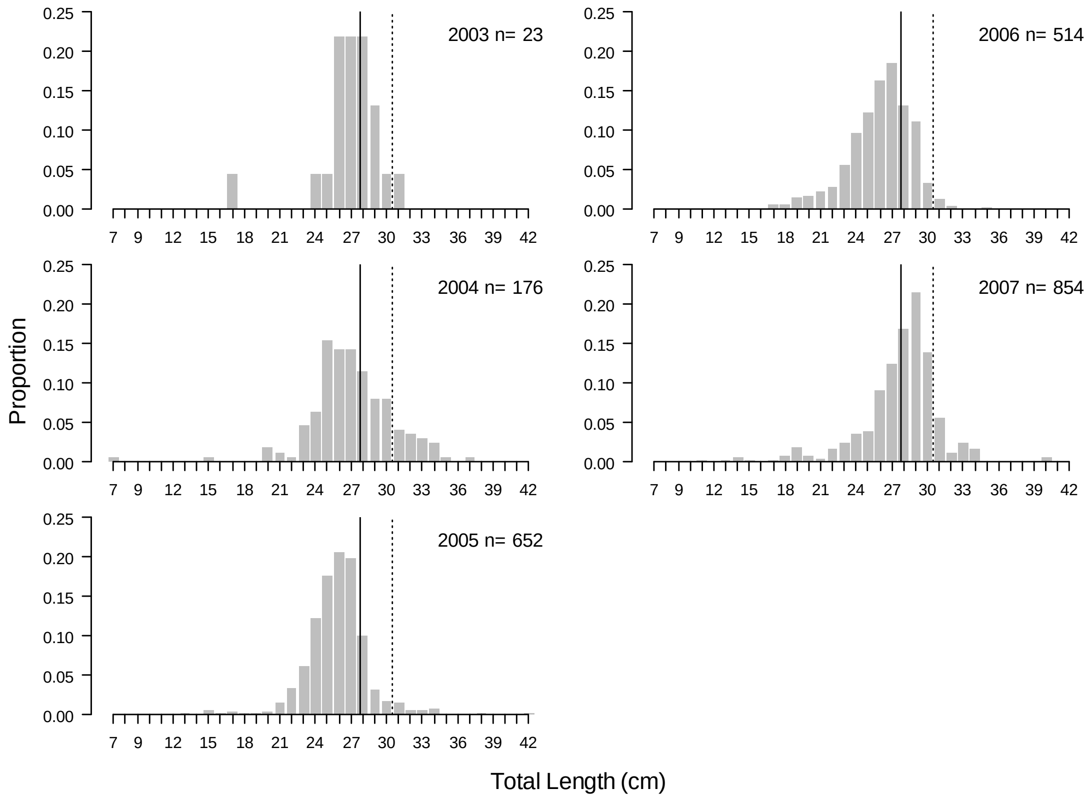


Figure 4.9.4. Age composition of vermilion snapper from the headboat fishery.

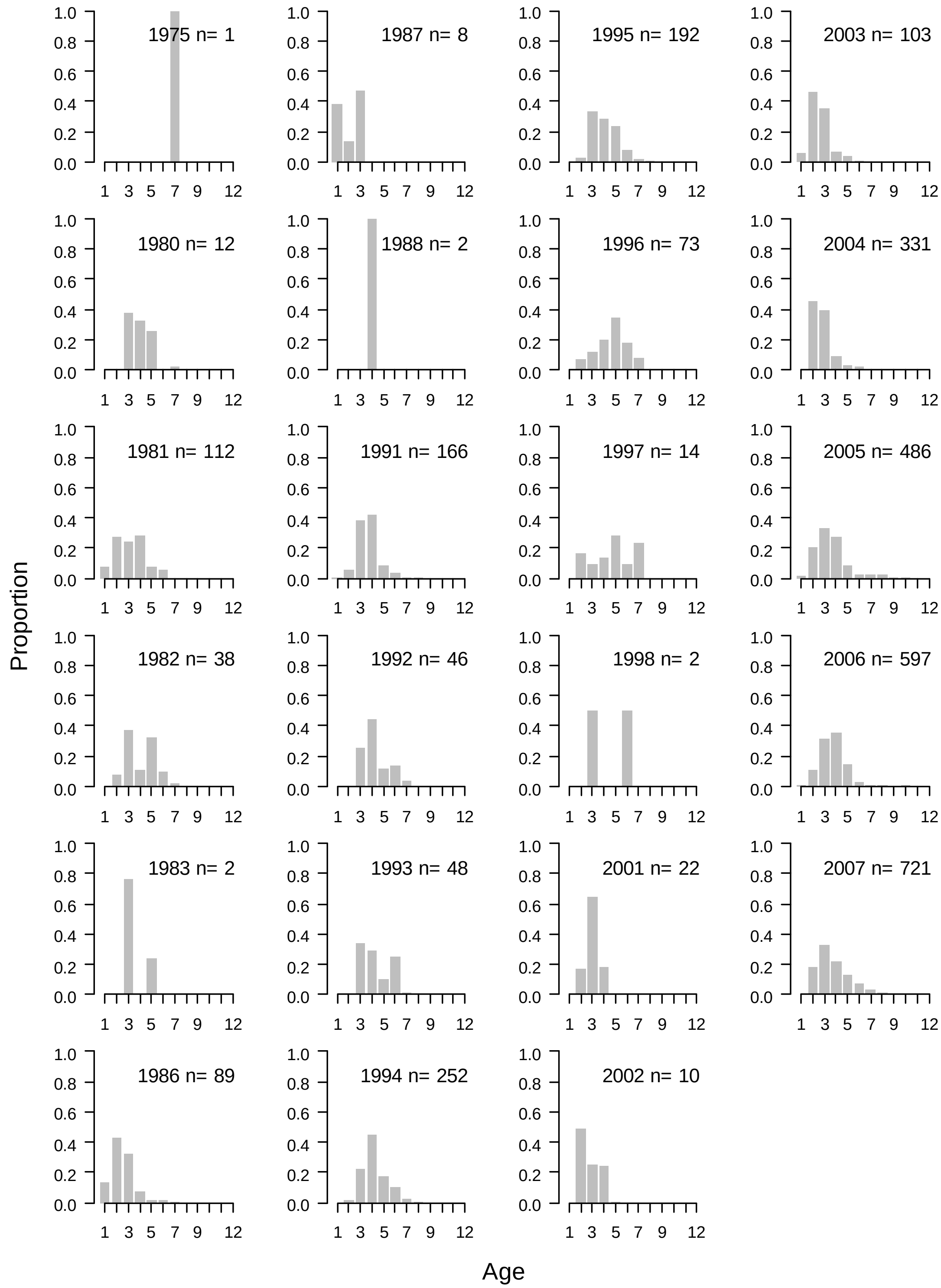


Figure 4.9.5. Number of headboat trips by region in the South Atlantic 1998-2007.

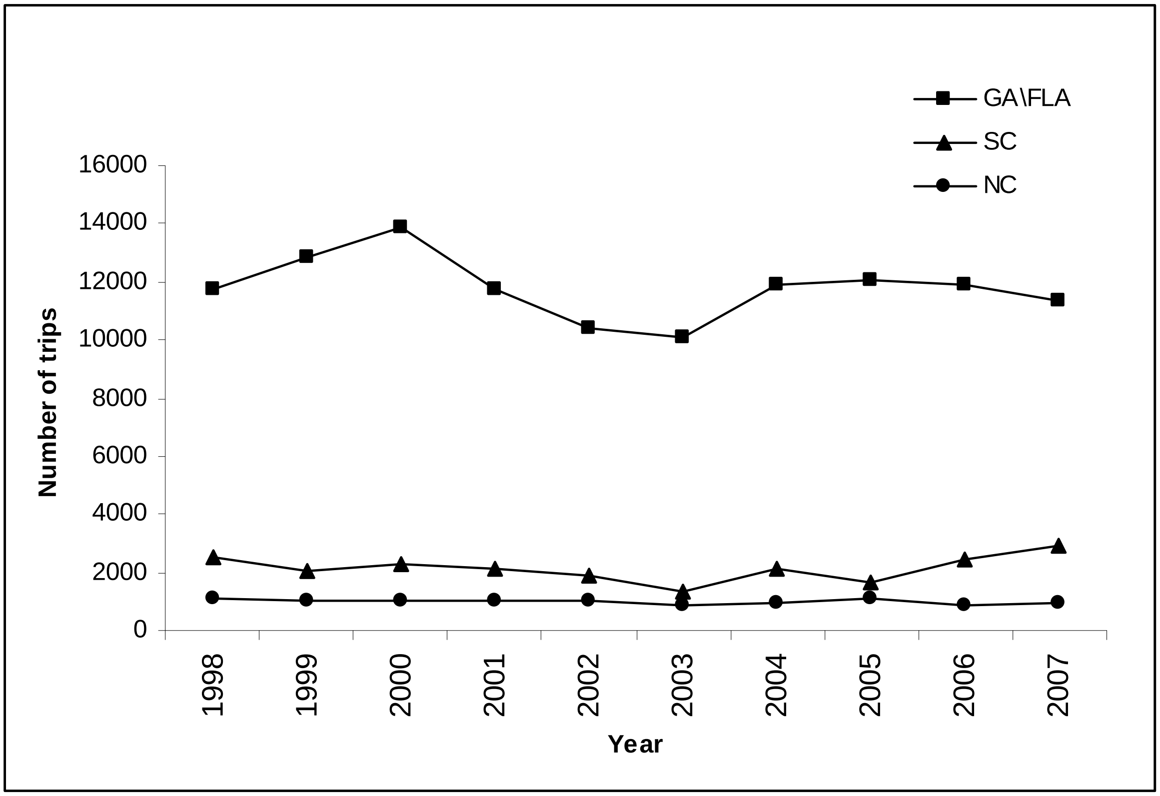


Figure 4.9.6. Proportion of headboat vermilion snapper landings relative to all recreational landings (headboat plus general recreational).

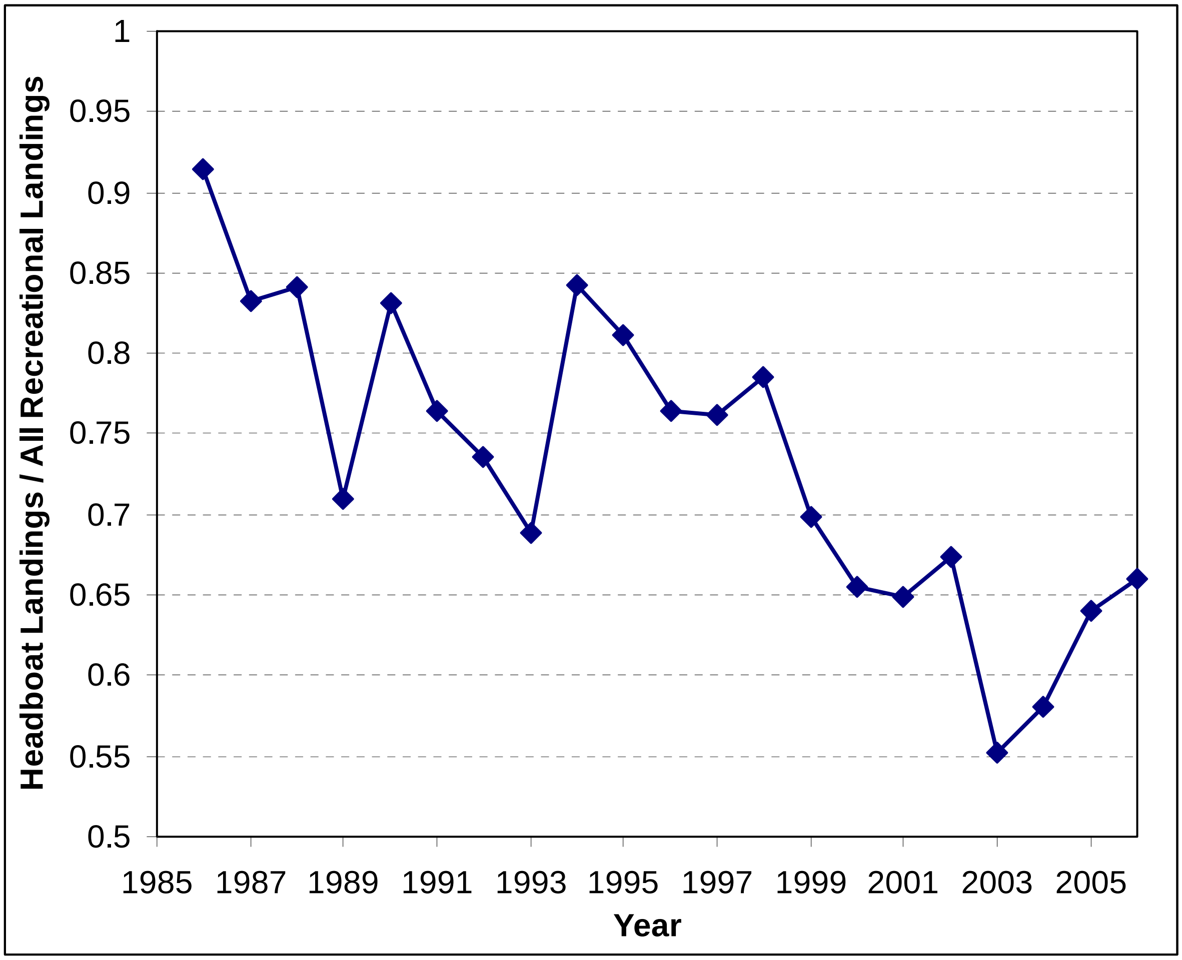


Figure 4.9.7. Proportion of headboat vermilion snapper landings relative to all snapper recreational landings minus yellowtail and red snapper.

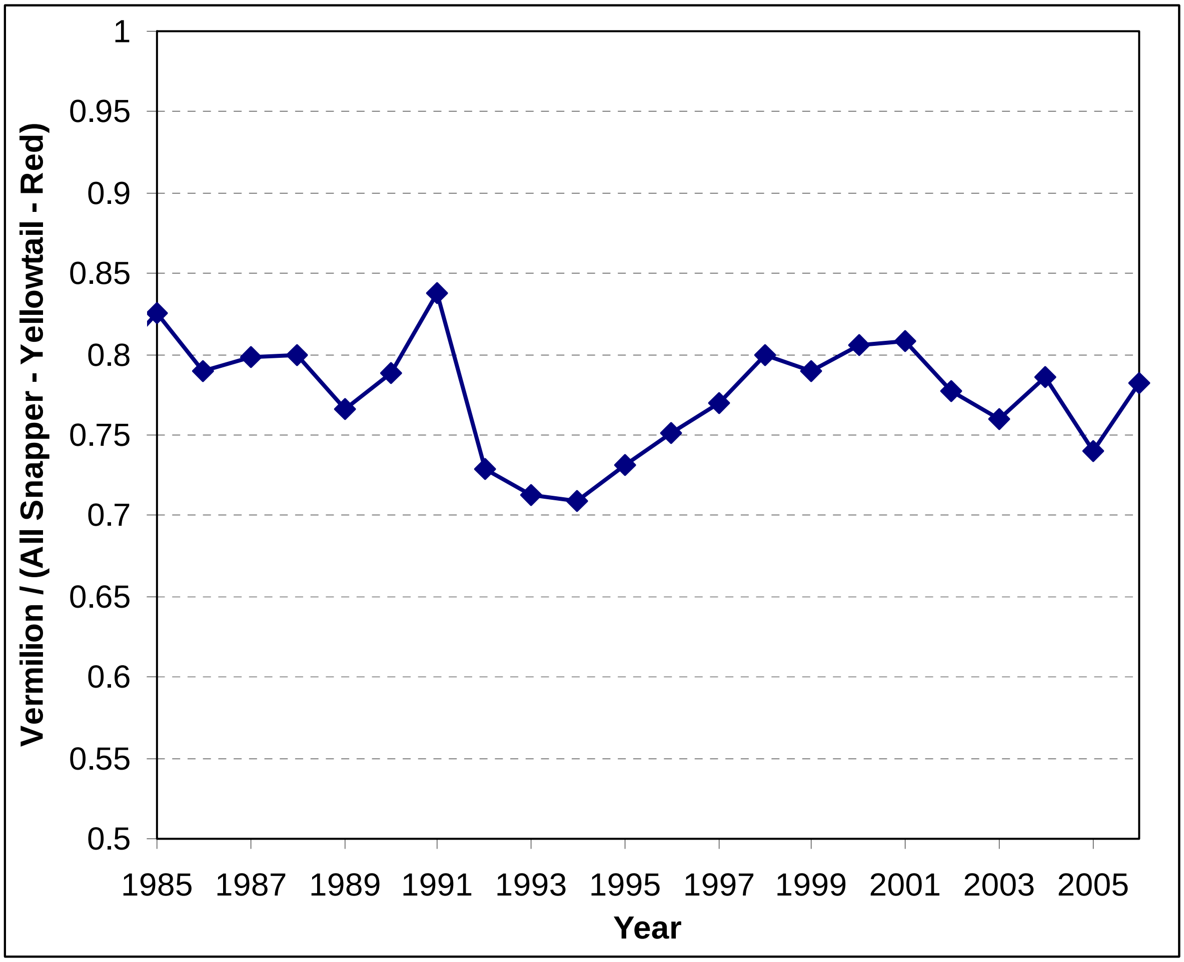


Figure 4.9.8. Vermilion snapper length composition from the general recreational sector provided by the MRFSS, 1 cm bins total length. The dashed line represents the 1992 10 inch size limit, solid line represents the 1999 11 inch size limit and the dotted line represents the 2007 12 inch size limit.

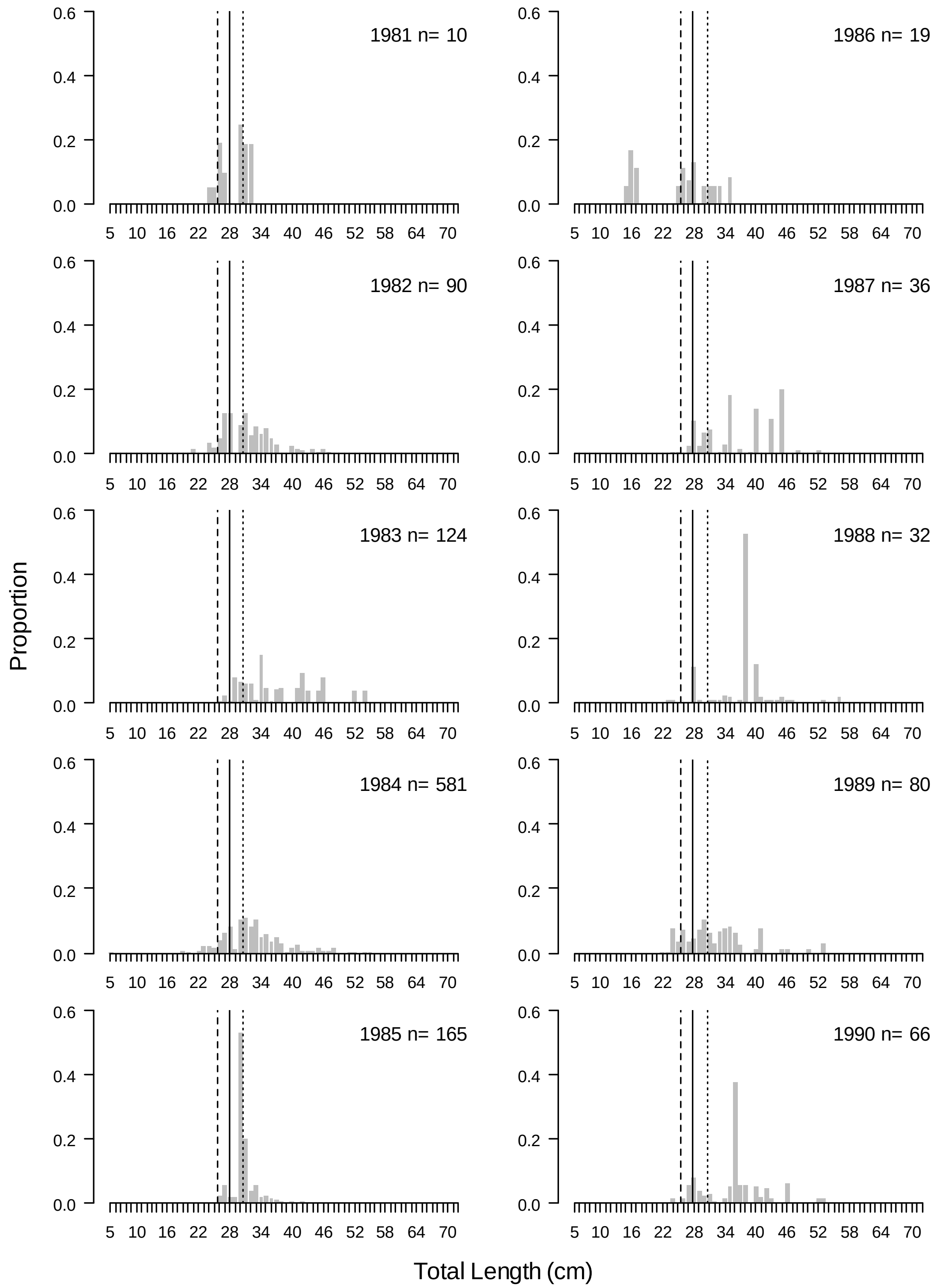


Figure 4.9.8. continued.

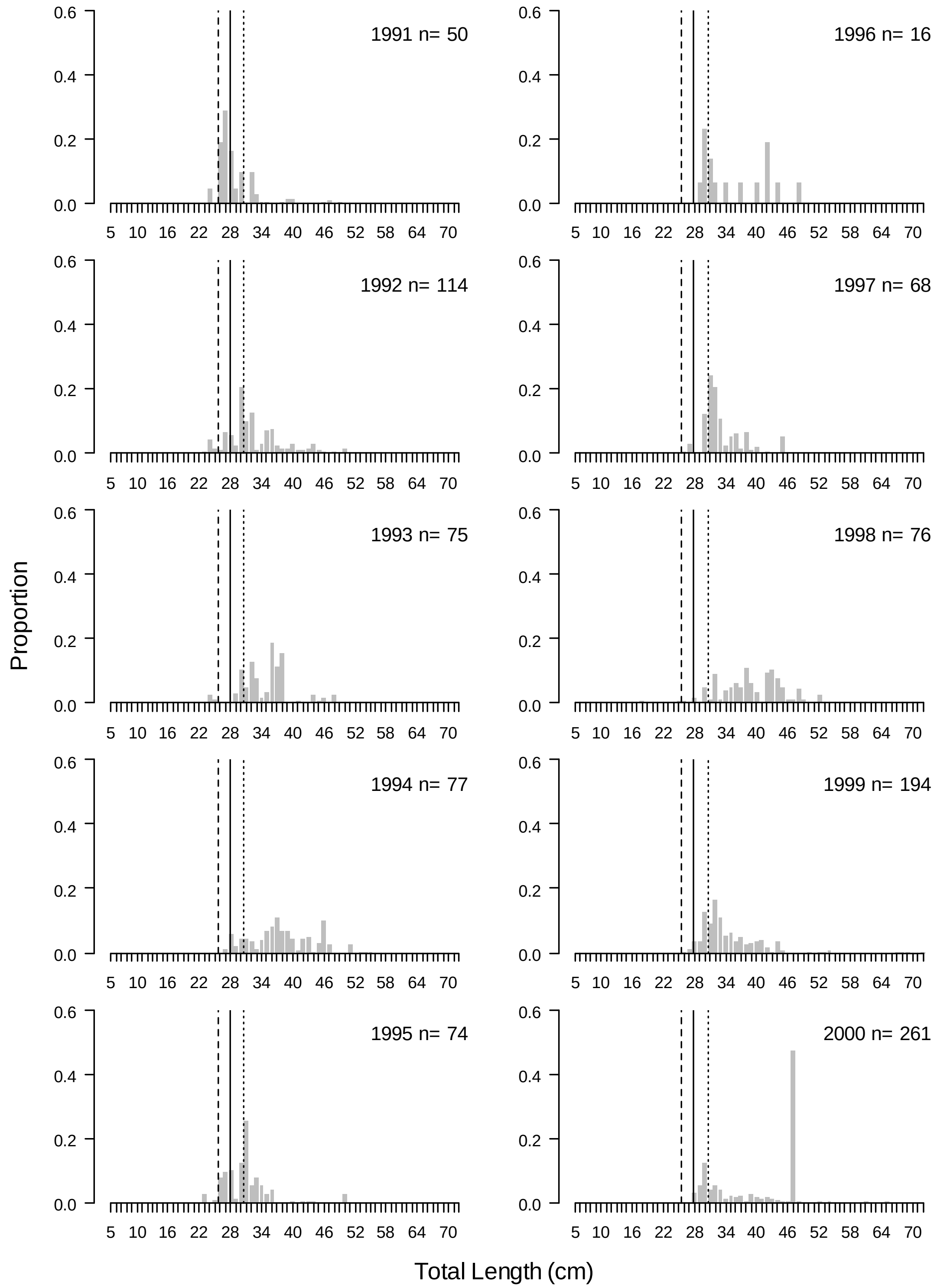


Figure 4.9.8. continued.

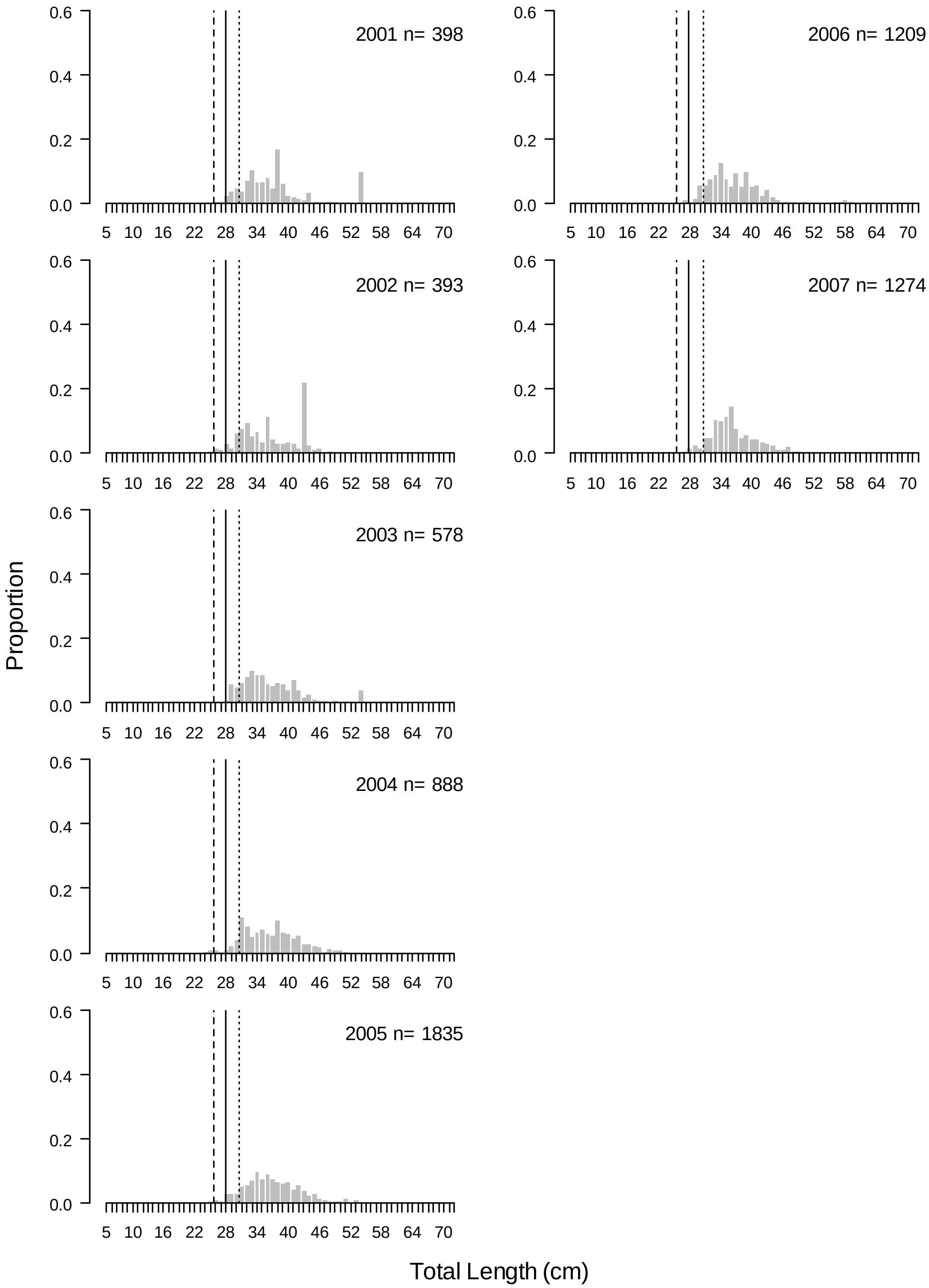
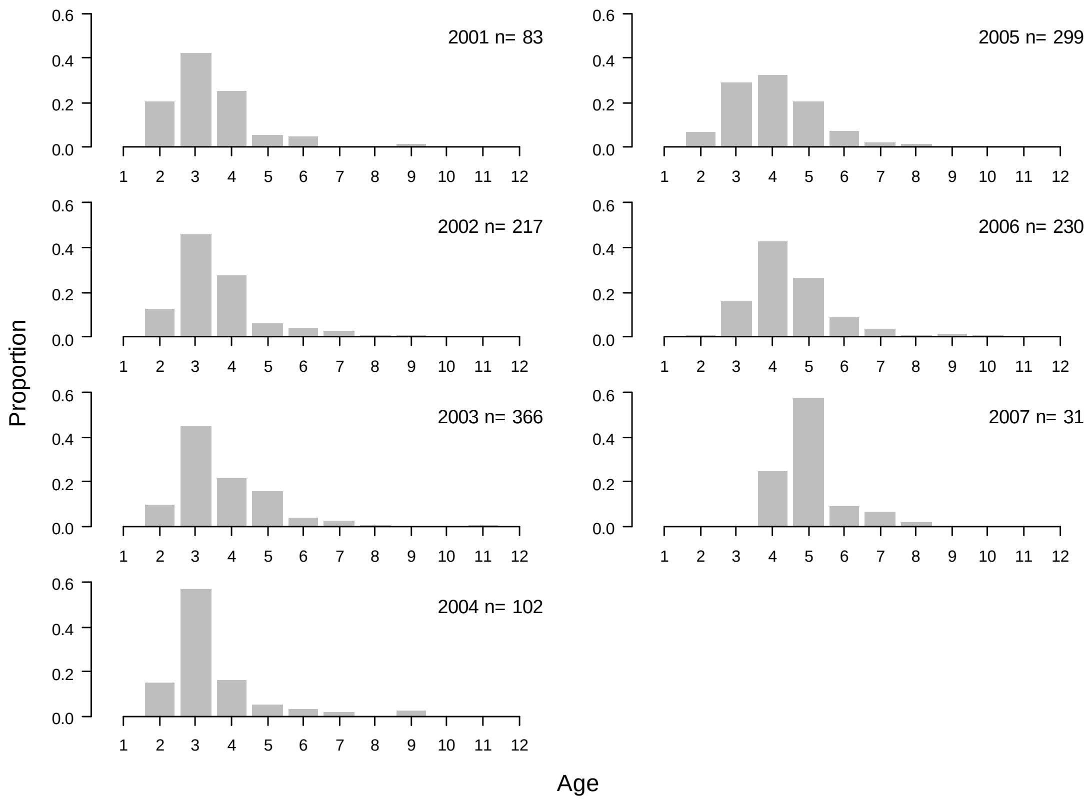


Figure 4.9.9. Age composition of vermilion snapper from the general recreation fishery. Private, charter modes are represented.



5. INDICATORS OF POPULATION ABUNDANCE

5.1 OVERVIEW

Several indices of abundance were considered for use in the assessment model. These indices are listed in Table 5.1, with pros and cons of each in Table 5.2. The possible indices came from fishery independent and fishery dependent data. The DW recommended the use of two fishery independent indices (one from MARMAP chevron traps and one from MARMAP Florida snapper traps) and three fishery dependent indices (one from commercial logbook data, one from headboat data, and one from general recreational data) (Table 5.1, 5.2).

Membership of this DW working group included Paul Conn, Julie DeFilippi, Pat Harris, Kyle Shertzer (leader), Helen Takada, Elizabeth Wenner, and Geoff White.

5.2 FISHERY INDEPENDENT INDICES

Vermilion snapper have been sampled by the MARMAP (Marine Resources Monitoring Assessment and Prediction) program using various gears (gears detailed in previous working paper SEDAR10-DW-05). Indices of abundance from two gear types were recommended for use in the assessment: chevron traps (1990–2007) and FL snapper traps (1983–1987). Other MARMAP gear types were considered, such as blackfish traps, hook & line, and vertical longlines, but were thought less likely to provide adequate indices for reasons described below.

In 1988 and 1989, FL snapper, blackfish, and chevron traps were fished synoptically for approximately 90 minutes from a 33.5 m research vessel that was anchored over randomly selected reef locations. Because of the proximity of the three types, and that hook and line sampling was occurring from the vessel at the same time the traps were deployed, the DW recommended that 1988 and 1989 be excluded from all fishery-independent indices developed.

In recent years, MARMAP has conducted a trap comparison study, which could allow for the possibility of extending the index from chevron traps back to years earlier than 1990. At this time, however, the working group considered that possibility to be premature, because the methods of data collection and analysis have not yet been adequately reviewed.

5.2.1 MARMAP CHEVRON TRAP

5.2.1.1 General description

Chevron traps were baited with cut clupeids and deployed at stations randomly selected by computer from a database of approximately 2,500 live bottom and shelf edge locations and buoyed (“soaked”) for approximately 90 minutes. Beginning in the 1990s, additional sites were selected, based on scientific and commercial fisheries sources, off North Carolina and south Florida to facilitate expanding the overall sampling coverage. The site expansion has been ongoing, with a few new sites added each year.

As a result, the survey has relatively extensive regional coverage; the average number of vermilion snapper collected in the traps each year between 1990 and 2007 was 1,320.3 (range 152–3,138, total 26,406). The CPUE averaged 2.47 fish/trap-hr with much variation (CV=348%). The high variability in the data may in part be due to the schooling behavior of vermilion snapper, and it was suggested that the index could be standardized using a delta-GLM approach, as described below. The DW also noted positive correlation between the chevron trap index and mean summer bottom temperatures as recorded during MARMAP sampling, and it was recommended that the GLM approach include bottom temperature as a predictor variable.

5.2.1.2 Methods

The CPUE from MARMAP chevron trap data was computed in units of number fish caught per trap-hour. The duration of the time series was 1990–2007. Spatial coverage included areas from Florida through North Carolina (Figure 5.1).

Standardized catch rates were estimated using a delta-GLM error structure (Lo et al., 1992; Stefánsson, 1996; Maunder and Punt, 2004), in which the binomial distribution describes positive versus zero CPUE, and either a lognormal or gamma distribution describes the positive CPUE (software described in SEDAR17-RD16). Lognormal and gamma models were both fitted, and the error structure with the lowest AIC was selected. In this case, the lognormal model was selected (gamma AIC = 11262; lognormal AIC = 10894). Explanatory variables considered, in addition to year (necessarily included), were bottom temperature (continuous variable), season (categorical variable), latitude (categorical variable), and depth (continuous variable). Both model components (binomial and lognormal) included main effects only. Season comprised spring (May and earlier), summer (June-August), or autumn (September and later), with most sampling in the summer (~73% of records).

Measures of precision were computed by a jackknife routine and summarized by the resulting CV. The jackknife routine iteratively refitted the delta-GLM model N times (N is the total sample size), where each iteration removed a unique record.

5.3.1.3 Sampling Intensity

The numbers of chevron trap sets and positive sets (i.e., caught vermilion snapper) are tabulated in Table 5.3.

5.2.1.4 Size/Age Data

Length compositions of chevron trap catches were available for all years of sampling (Table 5.4A). In general, vermilion snapper caught in chevron traps were between 15 and 40 cm of length. The lack of larger fish suggests that selectivity of the gear is dome-shaped. Age compositions were available starting in 2002 (Table 5.4B). Prior to 2002, fish were not necessarily selected at random for ageing.

5.2.1.5 Catch Rates and Measures of Precision

Diagnostic plots from the delta-GLM model fit are in Appendix 5.3. Table 5.5 shows nominal CPUE (fish/trap-hr), standardized CPUE, coefficients of variation (CV), and annual sample sizes (number trips). Figure 5.2 shows standardized and nominal CPUE.

5.2.1.6 Comments on Adequacy for Assessment

The DW concluded that the geographic coverage and relative high catch rates justified using chevron trap CPUE as an index of abundance in the assessment. However, concern was raised that annual variation in the index was unrealistically large, particularly in the early part of the time series. These fluctuations may be due in part to the schooling behavior of vermilion snapper, rather than to actual changes in abundance. The scale of sampling intensity (hundreds of sets per year spanning the entire South Atlantic Bight) might not be large enough to adequately characterize relative abundance of a schooling fish. The DW was also concerned that catchability in chevron traps might be influenced by bottom temperature, and noted positive correlation between the nominal chevron trap index and mean summer bottom temperatures (Pearson $\rho = 0.55$; p-value = 0.02 from a *t*-test of H_0: $\rho = 0$). Although the delta-GLM represented an attempt to account for bottom temperature in the index, it may not have been able to do so adequately if annual variation in temperatures across trap locations was inseparable from year effects.

5.2.2 MARMAP FLORIDA SNAPPER TRAP

5.2.2.1 General Description

From 1978 to 1987, Florida snapper traps baited with cut clupeids were soaked for approximately two hours during daylight at 12 study areas with known live-bottom and/or rocky ridges distributed from Onlsow Bay, NC to Fernandina Beach, FL. The DW noted that although sampling locations were not selected equally across the management area, samples were collected from what is thought to be the center of distribution of vermilion in the SAB. The total number of vermilion snapper caught between 1980 and 1987 was 2,037 (254/yr; range 24-471), the bulk of these fish were collected during 1983 through 1987, when four sample areas cited on the shelf break off South Carolina were added. The CPUE averaged 0.78 fish/trap-hr with much variation (CV=343%). The high variability in the data may in part be due to the schooling behavior of vermilion snapper, and it was suggested that the index could be standardized using a delta-GLM approach, as described below.

5.2.2.2 Methods

The CPUE from MARMAP FL snapper trap data was computed in units of number fish caught per trap-hour. The duration of the time series was 1983–1987. Spatial coverage included areas from Florida through North Carolina (Figure 5.3).

Standardized catch rates were estimated using a delta-GLM error structure (Lo et al., 1992; Stefánsson, 1996; Maunder and Punt, 2004), in which the binomial distribution describes positive versus zero CPUE, and either a lognormal or gamma distribution describes the positive CPUE (software described in SEDAR17-RD16). Lognormal and gamma models were both fitted, and the error structure with the lowest AIC was selected. In this case, the lognormal model was selected (gamma AIC = 1309; lognormal AIC = 1239). Explanatory variables considered, in addition to year (necessarily included), were season (categorical variable) and depth (continuous variable). Both model components (binomial and lognormal) included main effects only. Season comprised spring (May and earlier) or summer (June-August, but with a single record from September), with most sampling in the summer (~59% of records). Bottom temperature was not included as an explanatory variable here (as it was with chevron traps) because it was not recorded for most records. Latitude was not included here because sampling at 33 degrees and north was only in relatively shallow waters where encounters of vermilion snapper were rare (Figure 5.3), and depth was already included.

Measures of precision were computed by a jackknife routine and summarized by the resulting CV. The jackknife routine iteratively refitted the delta-GLM model N times (N is the total sample size), where each iteration removed a unique record.

5.2.2.3 Sampling Intensity

The numbers of FL snapper trap sets and positive sets (i.e., caught vermilion snapper) are tabulated in Table 5.3.

5.2.2.4 Size/Age Data

Length compositions of FL snapper trap catches were available for all years of sampling (Table 5.4C). In general, vermilion snapper caught in FL snapper traps were between 15 and 40 cm of length. The lack of larger fish suggests that selectivity of the gear is dome-shaped. Fish were not selected at random for ageing, and thus no age compositions are available.

5.2.2.5 Catch Rates and Measures of Precision

Diagnostic plots from the delta-GLM model fit are in Appendix 5.4. Table 5.6 shows nominal CPUE (fish/trap-hr), standardized CPUE, coefficients of variation (CV), and annual sample sizes (number trips). Figure 5.4 shows standardized and nominal CPUE.

5.2.2.6 Comments on Adequacy for Assessment

The DW concluded that the geographic coverage and catch rates of the FL snapper trap were adequate to use the CPUE as an index of abundance in the assessment. However, concern was raised that annual variation in the index was quite large. These fluctuations may be due in part to the schooling behavior of vermilion snapper, rather than to actual changes in abundance. Schooling could affect sampling in several ways, for example, if probability of being caught in a trap (trap-oriented behavior) varies with some unmeasured variable(s) or if there is high variance in the probability of a school being sampled (effects of school and sampling locations relative to sampling intensity). The scale of sampling intensity (hundreds of sets per year) might not be large enough to adequately characterize relative abundance of a schooling fish.

5.2.3 OTHER DATA SOURCES CONSIDERED

5.2.3.1 MARMAP Blackfish Trap

From 1978 to 1987, blackfish traps baited with cut clupeids were soaked for approximately two hours during daylight at eight midshelf study areas with known live-bottom and/or rocky ridges distributed from Onlsow Bay, NC to Fernandina Beach, FL.

Although vermilion snapper were sampled by this gear type, it was utilized as a tool to sample black sea bass, and did not provide consistent samples of vermilion snapper. Furthermore, all sites sampled with blackfish traps were also sampled using Florida snapper traps (see above), which provide a better index of abundance for vermilion snapper. For these reasons, the DW did not recommend using the MARMAP blackfish trap samples to develop an index of abundance off the southeastern U.S.

5.2.3.2 MARMAP Hook and Line

Hook and line stations were fished primarily during dawn and dusk periods, one hour preceding and after actual sunrise and sunset, however some fishing was also conducted synoptically with trap sampling. Rods utilizing Electromate motors powered 6/0 Penn Senator reels and 36 kg test monofilament line were fished for 30 minutes by three anglers. The terminal tackle consisted of three 4/0 hooks on 23 kg monofilament leaders 0.25 m long and 0.3 m apart, weighted with 0.5 to 1 kg sinkers. The top and bottom hooks were baited with cut squid and the middle hook baited with cut cigar minnow (*Decapterus sp.*). The same method of sampling was used from 1978 to 2007. However, less emphasis has been placed on hook and line sampling during the 1990s and 2000s to put more effort on tagging of fish at night and running between chevron and long line stations to increase sample coverage.

The total number of vermilion snapper caught between 1979 and 2007 was 2,404 (85.8/yr; range 0-483), the bulk of these fish were collected during 1988 and 1989 (888, 37%) and sample size was less than 50 in all years except three. Changes in personnel and level of effort have changed over time, compromising the utility of the hook and line survey as an index. Much of the hook and line effort was conducted over mid-shelf depths, and as such may not provide an adequate representation of the complete range of vermilion snapper. As a result, the DW did not recommend using the MARMAP hook and line samples to develop an index of abundance off the southeastern U.S.

5.2.3.3 MARMAP Short Bottom Long Line (vertical long line)

The short bottom long line was deployed to catch grouper/snapper over high relief and rough bottom types at depths of 90 to 200 m. This bottom line consisted of 25.6 m of 6.4 mm solid braid dacron groundline dipped in green copper naphenate. The line is deployed by stretching the groundline along the vessel's gunwale with 11 kg weights attached at the ends of the line. Twenty gangions baited with whole squid were placed 1.2 m apart on the groundline which was then attached to an appropriate length of poly warp and buoyed to the surface with a Hi-Flyer. Sets are made for 90 minutes and the gear is retrieved using a pot hauler.

Only two vermilion snapper have ever been captured using this gear type, and the DW did not recommend using the MARMAP short bottom long line samples to develop an index of abundance for vermilion snapper off the southeastern U.S.

5.2.3.4 Miscellaneous Sources

Other sources of fishery independent data were considered for a possible index of abundance, including MARMAP trawls, SEAMAP, NMFS Northeast Groundfish Trawl, and diver reports (reef.org). These sources sampled either no or insufficient numbers of vermilion snapper to be useful as an index of abundance.

5.3 FISHERY DEPENDENT INDICES

5.3.1 COMMERCIAL LOGBOOK (HANDLINE)

5.3.1.1 General Description

The NMFS collects catch and effort data by trip from commercial fishermen who participate in fisheries managed by the SAFMC. For each fishing trip, data collected include date, gear, fishing area, days at sea, fishing effort, species caught, and weight of the catch (Appendix 5.1). The logbook program in the Atlantic started in 1992. In that year, logs were collected from a random sample representing 20% of vessels; starting in 1993, all commercial fishermen holding snapper-grouper permits were required to submit logs. Using these data, an index of abundance was computed for 1993–2007.

5.3.1.2 Issues Discussed at the DW

Issue 1: Gear selection
Option 1: Include all gear types
Option 2: Include only handlines (composed of handline and electric reels)
Decision: Option 2, because greater than 97% of trips used handline.

Issue 2: Year selection
Option 1: Use data starting in 1992
Option 2: Use data starting in 1993
Decision: Option 2, because 1992 included only 20% coverage of fishermen, whereas 1993 began 100% coverage.

Issue 3:Defining which trips constitute effort
Option 1: Include only positive trips
Option 2: Use method of Stephens and MacCall (2004) to define effort that could have caught the focal species based on the composition of other species in the landings. This method would include trips with effort but zero landings.
Option 3: Option 2, but apply Stephens and MacCall separately to regions north and south of Cape Canaveral
Decision: Option 3, because it is likely that not all effective effort was successful at landing vermilion snapper, and because regions north and south of Cape Canaveral were found to have differences in species assemblages (Appendix 5.2).

Miscellaneous decisions

- The DW acknowledged that changes in fishing regulations could affect the ability of fishery dependent CPUE to track abundance. For the commercial sector, a 12-inch TL size limit was implemented on January 1, 1992; this regulation was implemented prior to the logbook time series, and was therefore not a concern. A commercial quota of 1.1 million pounds gutted weight was implemented on October 23, 2006, but this quota was not reached and was therefore not a concern.
- Species considered for the application of Stephens and MacCall (2004) were those in the Snapper-Grouper Fishery Management Plan. Some of these species were excluded if rare or not important to the regression, as described below in the Methods.

5.3.1.3 Methods

The CPUE from commercial logbook data was computed in units of pounds caught per hook-hour. The duration of the time series was 1993–2007. Spatial coverage included the entire management area, from east of the Florida Keys through North Carolina (i.e., through 36° latitude) (Figure 5.5). Each record describes weight (total lb) of a single species caught on a single trip, along with descriptive information of the trip, such as effort, date, and area fished.

Of trips that caught vermilion snapper, greater than 97% used handline gear, defined here as gear with code H or E (Appendix 5.1). Thus, the analysis included handline gear only. Excluded were records suspected to be misreported or misrecorded, as in previous SEDAR assessments (e.g., SAFMC, 2006): The variable "effort" (hooks/line) was constrained to be between 1 and 40 (inclusive), the variable "numgear" (number of lines) to be between 1 and 10 (inclusive); the variable "crew" (number on boat) to be fewer than 13, the variable "totlbs" (weight of catch) to be less than the 99th percentile (2726 lb) of vermilion snapper landings, cpue of vermilion snapper to be less than its 99th percentile (6.379 lb/hook-hr), and hours fished to allow only positive values. These constraints removed fewer than 1% of handline records. Also excluded were records that did not report area fished, number of lines, number of hooks, time fished, or days at sea.

Effective effort was based on those trips from areas where vermilion snapper were available to be caught. Without fine-scale geographic information on fishing location, trips to be included in the analysis must be inferred. To do so, the method of Stephens and MacCall (2004) was applied. The method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip. As mentioned previously, the method was applied separately to data from regions north and south of Cape Canaveral, because of differences in species assemblages (Figure 5.6A,B, Appendix 5.2). To avoid spurious correlations, species that were rarely caught were excluded from each regression: species were included as factors if caught in at least 1% of trips, with northern and southern regions considered separately. Model selection (i.e., choice of predictor species) was based on AIC using a backward stepwise algorithm (Venables and Ripley, 2002). The selected model (Table 5.7A,B) was used to compute for each trip a probability that vermilion snapper was caught, and a trip was then included if its associated probability was higher than a threshold probability (Figure 5.7A,B). The threshold was defined to be that which results in the same number of predicted and observed positive trips, as in Stephens and MacCall (2004). After applying Stephens and MacCall (2004) and the constraints described above, the resulting data set contained 29,338 trips, of which ~76% were positive.

Standardized catch rates were estimated using a delta-GLM error structure (Lo et al., 1992; Stefánsson, 1996; Maunder and Punt, 2004), in which the binomial distribution describes positive versus zero CPUE, and either a lognormal or gamma distribution describes the positive CPUE (software described in SEDAR17-RD16). Lognormal and gamma models were both fitted, and the error structure with the lowest AIC was selected. In this case, the gamma model was selected (gamma AIC = 75,018; lognormal AIC = 79,691). Explanatory variables considered, in addition to year (necessarily included), were month and geographic area. Both model components (binomial and gamma) included main effects only. Geographic areas reported in the logbooks were pooled into larger areas to provide adequate sample sizes for each level of this factor—NC (34°N ≤ latitude < 37°N), SC (32°N ≤ latitude < 34°N), GA (31°N ≤ latitude < 32°N), north FL (29°N ≤ latitude < 31°N), and south FL (latitude < 29°N).

Measures of precision were computed by a jackknife routine and summarized by the resulting CV. The jackknife routine iteratively refitted the delta-GLM model N times (N is the total sample size), where each iteration removed a unique record.

5.3.1.4 Sampling Intensity

The numbers of positive trips by year and area are tabulated in Table 5.8. The method of Stephens and MacCall (2004) does not necessarily select all positive trips.

5.3.1.5 Size/Age Data

Sizes and ages of fish represented by this index are the same as those of the commercial handline fishery (see chapter 3 of this DW report).

5.3.1.6 Catch Rates and Measures of Precision

Diagnostic plots from the delta-GLM model fit are in Appendix 5.5. Table 5.9 shows nominal CPUE (pounds/hook-hr), standardized CPUE, coefficients of variation (CV), and annual sample sizes (number trips selected by Stephens and MacCall method). Figure 5.8 shows standardized and nominal CPUE.

5.3.1.7 Comments on Adequacy for Assessment

The logbook index was recommended by the DW for use in the assessment. It had the advantages of wide geographic coverage and very large sample sizes, which could mitigate any effect of schooling on CPUE. The DW, however, did express several concerns about this data set (Table 5.2). It was pointed out that there are problems associated with any abundance index and that convincing counter-evidence needs to be presented to not use the logbook data.

Three concerns merit further description. First, commercial fishermen may target different species through time. If changes in targeting have occurred, effective effort can be difficult to estimate. However, the DW recognized that the method of Stephens and MacCall (2004), used here to identify trips for the analysis, can accommodate changes in targeting, as long as species assemblages are consistent.

Second, the data are self-reported and largely unverified. Some attempts at verification have found the data to be reliable, but problems likely remain, such as the possibility of misidentification of other species as vermilion snapper.

Third and probably foremost, the data are obtained from a directed fishery and therefore the index could contain problems associated with any fishery dependent index. Fishing efficiency of the fleet has likely increased over time due to improved electronics. In addition, overall efficiency may have changed throughout the time series if fishermen of marginal skill have left or entered the fishery at a greater rate than more successful fishermen. Also of concern is whether catch rates in a directed fishery are density-dependent. As fish abundance decreases, fishermen may maintain relatively high catch rates, and as fish abundance increases, catch rates may saturate.

The DW discussed how the assessment might attempt to account for changes in catchability over time. Constant catchability, though commonly assumed, would not be an appropriate assumption in this fishery, as the DW generally believed that catchability has increased with improvements in fishing gear and technology. The DW recommended that the base assessment model assume catchability increases by 2% per year, as was used in the SEDAR10 assessment of gag grouper (SAFMC, 2006) and SEDAR15 assessments of red snapper and greater amberjack (SAFMC, 2007a; SAFMC, 2007b). The DW further recommended that sensitivity runs consider increases of 0% (i.e., constant) and 4% per year.

5.3.2 RECREATIONAL HEADBOAT SURVEY

5.3.2.1 General Description

The headboat fishery is sampled separately from other recreational fisheries. The headboat fishery comprises large, for-hire vessels that generally charge a fee per angler and typically accommodate 20–60 passengers. Using the headboat data, an index of abundance was computed for 1976–2007.

5.3.2.2 Issues Discussed at the DW

<u>Issue 1: Include/exclude years prior to full area or vessel coverage</u>

Early years of headboat sampling did not have full area coverage. All headboats from North Carolina and South Carolina were sampled starting in 1973. Headboats from Georgia and northern Florida were sampled starting in 1976, and from southern Florida starting in 1978. All headboats across all areas were sampled starting in 1978.
Option 1: Use data starting in 1973
Option 2: Exclude early years; start the time series in 1976 (sampling did not include southern Florida)
Option 3: Exclude early years; start the time series in 1978 (begins 100% coverage).
Decision: Option 2, because most areas are represented throughout the time series; southern Florida is not represented in the first two years, but the delta-GLM model can account for predicted area effects.

<u>Issue 2:Defining which trips constitute effort</u>
Option 1: Include only positive trips
Option 2: Use method of Stephens and MacCall (2004) to define effort that could have caught the focal species based on the composition of other species in the landings. This method would include trips with effort but zero landings.
Option 3: Option 2, but apply Stephens and MacCall separately to regions north and south of Cape Canaveral
Decision: Option 3, because it is likely that not all effective effort was successful at landing vermilion snapper, and because regions north and south of Cape Canaveral were found to have differences in species assemblages (Appendix 5.2).

<u>Issue 3: Include/exclude years with 10 fish/angler bag limit</u>

Starting in 1992, with the implementation of a 10-fish bag limit, the percentage of headboat trips reporting greater than 10 vermilion snapper per angler remained low (Table 5.10), however the percentage of trips reporting exactly 10 vermilion snapper per angler rose from less than 2% annually to 7-11%. Concern was raised at the DW about whether a report of 10-fish per angler would accurately reflect the true number of vermilion snapper caught. Such a report might be an underestimate of the actual number caught for at least two reasons: 1) headboat operators may not wish to document in

writing a value that exceeds the regulation, and 2) vermilion snapper caught in excess of the bag limit would be released, if caught on headboat trips that were in compliance with regulations.
Option 1: End the time series in 1991.
Option 2: Use the entire time series of 1976-2007.
Decision: Option 2, because sensitivity analyses revealed that if reports of 10 fish per angler in 1992-2007 were erroneous, any effect on the index of abundance would be small (SEDAR17-DW11). The DW considered adjusting data at the trip level to account for such reports, but could only do so by making unverifiable assumptions, and thus decided to use the data as reported.

Miscellaneous decisions

- A 10-inch TL size limit was implemented on January 1, 1992, which was increased to 11 inches on February 24, 1999, and then again to 12 inches on October 23, 2006. The DW acknowledged that size limits could be accounted for by the assessment model through estimation of selectivity.
- Species considered for the application of Stephens and MacCall (2004) were those in the Snapper-Grouper Fishery Management Plan. Some of these species were excluded if rare or not important to the regression, as described below in the Methods.

5.3.2.3 Methods

The CPUE was computed in units of number of fish per hook-hour. The duration of the time series was 1976–2007. Spatial coverage included the entire management area (Figure 5.9). Few vessels have operated in Area 1 (NC outer banks) throughout the time series, and so any vessels sampled from that area were lumped with Area 10 (immediately south), and Area 1 was excluded from the analysis. Trips were trimmed from the analysis if the number of vermilion snapper landed was in the upper 1% or if CPUE was in the upper 1%, to exclude outliers suspected to be misreported or misrecorded. Also excluded were records that did not report fields necessary to compute catch per unit effort.

Effective effort was based on those trips from areas where vermilion snapper were available to be caught. Without fine-scale geographic information on fishing location, trips to be included in the analysis must be inferred. To do so, the method of Stephens and MacCall (2004) was applied. The method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip. As mentioned previously, the method was applied separately to data from regions north and south of Cape Canaveral, because of differences in species assemblages (Figure 5.10A,B, Appendix 5.2). To avoid spurious correlations, species that were rarely caught were excluded from each regression: species were included as factors if caught in at least 1% of trips, with northern and southern regions considered separately. Model selection (i.e., choice of predictor species) was based on AIC using a backward stepwise algorithm (Venables and Ripley, 2002). The selected model (Table 5.11A,B) was used to compute for each trip a probability that vermilion snapper was caught, and a trip was then included if its associated probability was higher than a threshold probability (Figure 5.11A,B). The threshold was defined to be that which results in the same number of predicted and observed positive trips, as in Stephens and

MacCall (2004). After applying Stephens and MacCall (2004) and the constraints described above, the resulting data set contained 86,567 trips, of which ~42% caught vermilion snapper.

Standardized catch rates were estimated using a delta-GLM error structure (Lo et al., 1992; Stefánsson, 1996; Maunder and Punt, 2004), in which the binomial distribution describes positive versus zero CPUE, and either a lognormal or gamma distribution describes the positive CPUE (software described in SEDAR17-RD16). Lognormal and gamma models were both fitted, and the error structure with the lowest AIC was selected. In this case, the gamma model was selected (gamma AIC = –8052; lognormal AIC = –4103). Explanatory variables considered, in addition to year (necessarily included), were month, geographic area, and trip type (half-day or full-day trips). Both model components (binomial and gamma) included main effects only. Geographic areas reported were pooled into larger areas to provide adequate sample sizes for each level of this factor—NC, SC, GA and north FL combined, and south FL.

Measures of precision were computed by a jackknife routine and summarized by the resulting CV. The jackknife routine iteratively refitted the delta-GLM model N times (N is the total sample size), where each iteration removed a unique record.

5.3.2.4 Sampling Intensity

The numbers of positive trips by year and area are tabulated in Table 5.12. The method of Stephens and MacCall (2004) does not necessarily select all positive trips.

5.3.2.5 Size/Age Data

Sizes and ages of fish represented by this index are the same as those sampled by the headboat survey (see chapter 4 of this DW report).

5.3.2.6 Catch Rates and Measures of Precision

Diagnostic plots of residuals from the delta-GLM model fit are in Appendix 5.6. Table 5.13 shows nominal CPUE (fish/angler-hr), standardized CPUE, coefficients of variation (CV), and annual sample sizes (number trips selected by Stephens and MacCall method). Figure 5.12 shows standardized and nominal CPUE.

5.3.2.7 Comments on Adequacy for Assessment

The headboat index was recommended by the DW for use in the assessment. It had the advantages of wide geographic coverage and very large sample sizes, which could mitigate any effect of schooling on CPUE. However, the DW did discuss several concerns (Table 5.2). One concern was that this index may contain problems associated with fishery dependent indices, as described in section 5.3.1.7. The DW, however, did note that the headboat fishery is not a directed fishery for vermilion snapper. Rather, it more generally fishes a complex of snapper-grouper species, and does so with only limited search time. Thus, the headboat index may be a more reliable index of abundance than one developed from a fishery that targets vermilion snapper specifically.

The DW discussed how the assessment might attempt to account for changes in catchability over time. Constant catchability, though commonly assumed, would not be an appropriate assumption in this fishery, as the DW generally believed that catchability has increased with improvements in fishing gear and technology. The DW recommended that the base assessment model assume catchability increases by 2% per year, as was used in the SEDAR10 assessment of gag grouper (SAFMC, 2006) and SEDAR15 assessments of red snapper and greater amberjack (SAFMC, 2007a; SAFMC, 2007b). The DW further recommended that sensitivity runs consider increases of 0% (i.e., constant) and 4% per year.

5.3.3 RECREATIONAL INTERVIEWS

5.3.3.1 General Description

The general recreational fishery is sampled by the Marine Recreational Fisheries Statistics Survey (MRFSS). This general fishery includes all recreational fishing from shore, man-made structures, private boats, and charter boats (for-hire vessels that usually accommodate six or fewer anglers). Party boats were removed from this analysis because they are sampled by the headboat survey. Using the MRFSS data from the South Atlantic region, that is Currituck County, North Carolina through Miami-Dade County, Florida (Figure 5.13), an index of abundance was computed for 1987–2007.

5.3.3.2 Issues Discussed at DW

Issue 1: Trip selection
Option 1: Select angler-trips based on the method of Stephens and MacCall (2004)
Option 2: Use MRFSS data on effective effort to select angler-trips: Apply proportion of intercepted trips that were "directed" [i.e., targeted or caught (A1+B1+B2)] to estimates of total marine recreational angler-trips.
Option 3: Use MRFSS data on effective effort to select angler-trips: Apply proportion of intercepted trips that were "directed" [i.e., targeted or harvested (A1+B1 only)] to estimates of total marine recreational angler-trips.
Decision: Option 2 preferred. MRFSS data contain information on targeted species. Although this information may lead to underestimates of effective effort, it does identify effective effort explicitly, whereas the method of Stephens and MacCall (2004) does so implicitly. The DW noted that this index includes all catches (landings plus discards), and should be applied as such in the assessment model. Thus, to be of use, this index would require a selectivity curve of all catch (not just landings). If such a curve cannot be estimated reliably in the assessment model, a MRFSS index using landings only was also computed (option 3).

Issue 2: First year of time series
Option 1: Start the time series in 1982, the first year of data collection.
Option 2: Start the time series in 1987, because of increased sampling intensity starting in 1987, reflected in the increase in sample sizes.
Decision: Option 2. The DW decided to start the time series in 1987, when sampling intensity increased substantially (Table 5.14).

<u>*Miscellaneous decisions*</u>

- The group acknowledged the possibility that some vermilion snapper were misreported as other snappers, particularly red snapper. However, it was not feasible to identify which trips might have misreported, much less correct data at the level of trip, and thus MRFSS data were used as reported. It was assumed that if vermilion snapper were misreported, the misreporting was not systematic.

- A 10-inch TL size limit was implemented on January 1, 1992, which was increased to 11 inches on February 24, 1999, and then again to 12 inches on October 23, 2006. The DW acknowledged that size limits could be accounted for by the assessment model through estimation of selectivity.
- A bag limit of 10 vermilion snapper/person/day was instituted for the recreational fishery in 1992. The DW examined the occurrence of reaching and exceeding the bag limit and concluded that, because of low occurrence (generally <5% of trips per year), any influence on the index of abundance would be small (Table 5.15). Furthermore, it was believed that recreational fishermen would generally continue to fish after reaching the bag limit and would simply discard fish if necessary to remain in compliance, and therefore bag limits would have little or no influence on fishing behavior. In addition, the index includes discards, which would reduce further any possible influence.
- Estimates of CV of the catch per effort are not obtainable, but instead were represented by proportional standard error (PSE) of total catch.

5.3.3.3 Methods

The CPUE was computed in units of number fish per angler-trip. The method chosen produced unbiased estimates of "directed" angler trips by applying the proportion of intercepted trips that were "directed" toward vermilion snapper to estimates of total marine recreational angler trips. Directed trips were defined in two ways. First, directed trips were defined as those trips where vermilion snapper was listed as targeted (under the variables “prim1” or “prim2”) or caught (A1+B1+B2). Type B2 group catches (fish released alive) were assigned angler-trip values based on the leader with additional anglers acting as followers. Second, directed trips were defined as targeted (under the variables “prim1” or “prim2”) or harvested (A1+B1 only). The proportion of directed trips was calculated based on the count of directed trips relative to all samples taken in a year/state/wave/mode/area strata. That proportion was then applied to the effort estimate for the same strata and summed up to the year/region level. The MRFSS data used included those areas ranging from North Carolina to the east coast of Florida excluding Monroe County. The directed trip analysis was obtained from the Atlantic Coastal Cooperative Statistics Program website (ACCSP, 2008).

5.3.3.4 Sampling Intensity

Sampling intensity (number of intercepted angler-trips) by state is shown in Table 5.14.

5.3.3.5 Size/Age Data

Sizes and ages of fish represented by this index are the same as those of the recreational fishery as sampled by the MRFSS (see chapter 4 of this DW report).

5.3.3.6 Catch Rates and Measures of Precision

Table 5.16 shows nominal CPUE (number/angler-trip) and estimates of precision, as does Figure 5.14.

5.3.3.7 Comments on Adequacy for Assessment

The MRFSS index was recommended by the DW for use in the assessment. However, the DW did discuss several concerns (Table 5.2). One concern was that this index may contain problems associated with fishery dependent indices, as described in section 5.3.1.7. Another concern was the large uncertainty in MRFSS landings and effort estimates. The data were not collected with intention of providing an index of abundance.

The DW discussed how the assessment might attempt to account for changes in catchability over time. Constant catchability, though commonly assumed, would not be an appropriate assumption in this fishery, as the DW generally believed that catchability has increased with improvements in fishing gear and technology. The DW recommended that the base assessment model assume catchability increases by 2% per year, as was used in the SEDAR10 gag grouper assessment (SAFMC, 2006), and that sensitivity runs consider increases of 0% (i.e., constant) and 4% per year.

5.4 CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATIONS

Two fishery independent indices were recommended for use in the assessment: MARMAP chevron trap and FL snapper trap. Three fishery dependent indices were recommended: commercial handline (logbook), headboat, and MRFSS (Tables 5.1, 5.2). The five indices are compared graphically in Figure 5.15 and their correlations in Table 5.17.

The DW spent considerable time discussing negative correlations between indices, in particular between indices from the headboat data and MARMAP chevron trap data. The headboat index suggests a generally increasing trend over the last 15 years, while the chevron trap index suggests a generally decreasing trend. Trends aside, the DW considered the headboat index to be more reliable, because of its large annual sample sizes (thousands of trips), wide geographic and depth coverage, and its generalist approach to fishing snapper-groupers (i.e., doesn’t specifically target vermilion snapper, but rather fishes a complex of species). The chevron trap data are collected from well-designed fishery independent sampling, but concern was raised that the annual sampling intensity (hundreds of sets) might not be sufficient to characterize reliably the overall abundance of a schooling fish such as vermilion snapper. Perhaps related, variability in early years of the index was not considered biologically plausible (e.g., 500% population increase in 1991, followed immediately by a 50% decrease). In addition, correlation between bottom temperature and chevron trap CPUE raised concern about a possible effect of temperature on catchability (Appendix 5.7); use of the delta-GLM represented an attempt to account for bottom temperature in the index, but may not have been able to do so adequately if annual variation in temperatures across trap locations was inseparable from year effects. Although not considered justification by the DW for favoring either index, the recent increasing trend of the headboat index was noted to be in better agreement with anecdotal reports from fishermen’ perception of the stock.

After considering pros and cons of each index (Table 5.2), the DW ranked the indices according to its perception of most (1) to least (5) reliable:

1. Headboat
2. MARMAP chevron trap
3. Commercial logbook
4. MARMAP FL snapper trap
5. MRFSS

The DW also noted that the diverging trends in indices, especially between headboat and chevron trap indices, would be difficult for an assessment model to fit simultaneously. Different runs of the assessment model might consider various schemes of preferential weighting of indices, or even various schemes of inclusion/exclusion of indices.

5.5 RESEARCH RECOMMENDATIONS

1. Expand fishery independent sampling to provide indices of abundance.

2. Examine variability in catchability

    - Environmental effects
    - Changes over time associated with increases in technology and potential changes in fishing practices. This is of particular importance when considering fishery dependent indices.
    - Potential density-dependent changes in catchability. This is of particular importance for schooling fishes.

3. Examine possible temporal changes in species assemblages. Such changes could influence how the Stephens and MacCall method is applied when determining effective effort.

4. Continue and expand fishery dependent at-sea-observer surveys. Such surveys collects discard information, which would provide for a more accurate index of abundance.

5. Review/analyze MARMAP trap comparison study.

5.6 ITEMIZED LIST OF TASKS FOR COMPLETION FOLLOWING WORKSHOP

- Standardize MARMAP indices
- Generate any remaining tables and figures
- Finish writing chapter of DW report
- Submit data to Data Compiler

5.7 LITERATURE CITED

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5.8 TABLES

Table 5.1. Vermilion snapper: A summary of catch-effort time series available for the SEDAR 17 data workshop.

Fishery Type	Data Source	Area	Years	Units	Standardization Method	Size Range	Issues	Use?
Recreational	Headboat	NC-FL	1976-2007	Number per angler-hr	Stephens and MacCall; delta-GLM	Same as fishery	Fishery dependent	Y
Commercial	Logbook - handline	NC-FL	1993-2007	Pounds per hook-hr	Stephens and MacCall; delta-GLM	Same as fishery	Fishery dependent	Y
Recreational	MRFSS	NC-FL	1987-2007	Number per angler-trip	Angler-trips included if species was targeted or caught (A+B1+B2); Nominal	Same as fishery	Fishery dependent	Y
Independent	MARMAP Chevron trap	NC-FL	1990-2007	Number per trap-hr	delta-GLM	Generally 15-40 cm	High variability	Y
Independent	MARMAP Florida trap	NC-FL	1983-1987	Number per trap-hr	delta-GLM	Generally 15-40 cm	High variability	Y
Independent	MARMAP Blackfish trap	NC-FL	1978-1987	Number per trap-hr	—	—	Low numbers of samples	N
Independent	MARMAP Hook and line	NC-FL	1979-1998	Number per hook-hr	—	—	Inconsistent sampling effort over time	N
Independent	MARMAP Short longline	NC-FL	1980-2007	Number per hook-hr	—	—	Very low sample sizes	N
Independent	MARMAP trawl	NC-FL	1980-1987		—	—	Low numbers of samples	N
Independent	SEAMAP	NC-FL	1990-2007	Number per hectare	—	—	Very low sample sizes	N
Independent	NMFS Northeast Groundfish Trawl	ME - Cape Hatteras	1972-2007	Number per trawl	—	—	Low sample sizes	N
Independent	Diver Reports (Reef.org)	NC-FL	1990-2007	—	—	—	Voluntary reporting	N
Recreational	NC Citation Program	NC	?-2007	—	—	—	Voluntary reporting, variable publicity, target species may not be included in program	N
Recreational	Online recreational trip reporting (myfish.com)	NC-FL	2007	—	—	—	Voluntary reporting, currently only on year of data available	N

Table 5.2. Issues with each data set considered for CPUE.

Fishery dependent indices

Commercial Logbook – Handline (*Recommended for use*)

Pros:
- Complete census
- Covers entire management area
- Continuous, 15-year time series
- Large annual sample size

Cons:
- Fishery dependent (targeting)
- Data are self-reported and largely unverified
- Little information on discard rates
- Catchability may vary over time and/or abundance

Issues Addressed:
- Possible shift in species preference [Stephens and MacCall (2004) approach]
- In some cases, self-reported landings have been compared to TIP data, and they appear reliable
- Increases in catchability over time (e.g., due to advances in technology or knowledge) can be addressed in the assessment model

Recreational Headboat (*Recommended for use*)

Pros:
- Complete census
- Covers entire management area
- Longest time series available
- Data are verified by port samplers
- Consistent sampling
- Large annual sample size
- Generally non-targeted for focal species

Cons:
- Fishery dependent
- Little information on discard rates
- Catchability may vary over time and/or abundance

Issues Addressed:
- Possible shift in species preference [Stephens and MacCall (2004) approach]
- The impression of some people that trip duration has shifted toward half-day trips is not consistent with the data (Exploratory data analysis reveals no such shift on vermilion snapper trips or on headboat trips overall. In addition, trip duration is accounted for as a factor in the GLM.)
- Increases in catchability over time (e.g., due to advances in technology or knowledge) can be addressed in the assessment model

MRFSS (*Recommended for use*)

Pros:
- Relatively long time series

Nearly complete area coverage (excluded Monroe County)
Only fishery dependent index to include discard information (A+B1+B2)

Cons: Fishery dependent
High uncertainty in MRFSS data
Targeted species (fields prim1 and prim2) are missing for many observations in the data set
When fishing a multispecies assemblage, such as the snapper-grouper complex, it is likely that fishermen would list target species other than vermilion snapper when only able to record a maximum of two species. Trips would be eliminated from the analysis if anglers fished in areas where vermilion snapper were likely to be present but were not actually caught, thus causing effort to be underestimated.

North Carolina Citation Program (*Not recommended for use*)

Pros: May correlate with changes in size over time

Cons: No measure of effort
Fishery dependent
Limited geographic coverage
Not designed to provide information on abundance
Dependent on fishermen to call in and report citations

Online Recreational Logbooks (www.myfish.com) (*Not recommended for use*)

Pros: Ancillary information collected (e.g., weather conditions)

Cons: Voluntary reporting
Fishery dependent
Not designed to provide information on abundance
Only one year (2007) not meaningful as an index

<u>Fishery independent</u>

MARMAP

Chevron Trap Index (*Recommended for use*)

Pros: Fishery independent random hard bottom survey
Adequate spatial coverage
Standardized sampling techniques

Cons: High variability
Unknown if sampling intensity (100s sets per year) is adequate to characterize region-wide abundance of a schooling fish

FL Snapper Trap Index (*Recommended for use*)

Pros: Fishery independent random hard bottom survey
Adequate spatial coverage, concentrated at center of species' range
Standardized sampling techniques

Cons: High variability

Unknown if sampling intensity (100s sets per year) is adequate to characterize region-wide abundance of a schooling fish
Short time series (5 years)

Blackfish Trap Index (*Not recommended for use*)
Pros: Fishery independent
Cons: Inadequate sample sizes
Sampled same sites as FL snapper traps, a better gear for vermilion snapper

Hook and Line Index (*Not recommended for use*)
Pros: Fishery independent random hard bottom survey
Adequate regional coverage
Standardized sampling techniques
Cons: Low sample sizes in most years
Restricted depth coverage (midshelf sampled)
High standard errors
Ability of samplers may have changed over time
Level of effort has decreased over time
Sampling conducted alongside trap surveys, so not independent of other gears. Intent was supplemental sampling of hard parts.

Short Bottom Longline Index (*Not recommended for use*)
Pros: Fishery independent
Cons: Inadequate sample sizes

Trawl (*Not recommended for use*)
Pros: Fishery independent
Cons: Inadequate sample sizes

SEAMAP Trawl Survey (*Not recommended for use*)
Pros: Stratified random sample design
Adequate regional coverage
Standardized sampling techniques
Cons: Limited depth coverage (shallow water survey)
Inadequate sample sizes

Diver Reports (www.reef.org) (*Not recommended for use*)
Pros: Trained divers
Visual account of species present
Cons: Not designed with objective of providing an index of abundance
Sample sizes off the southeastern U.S. (dives documenting vermilion snapper) reported on the website appear to be low

Table 5.3 Sampling intensity (number of trap sets and number of sets that caught vermilion snapper) of MARMAP gears Florida snapper trap and chevron trap.

	Florida snapper trap		Chevron trap	
Year	N sets	N positive	N sets	N positive
1983	165	47		
1984	259	62		
1985	260	66		
1986	228	67		
1987	346	61		
1988				
1989				
1990			274	77
1991			278	138
1992			293	102
1993			412	128
1994			410	174
1995			388	135
1996			519	168
1997			505	107
1998			485	112
1999			254	74
2000			328	108
2001			288	91
2002			292	116
2003			280	41
2004			327	73
2005			336	84
2006			349	58
2007			390	87

Table 5.4A Length compositions (cm) and sample sizes of vermilion snapper caught in MARMAP chevron traps.

LEN (cm)	N	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1990	830	0.000	0.000	0.000	0.006	0.134	0.280	0.195	0.133	0.101	0.059	0.031	0.019	0.014	0.010	0.002	0.005	0.001	0.005	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
1991	3066	0.000	0.000	0.003	0.029	0.149	0.279	0.229	0.155	0.075	0.034	0.014	0.009	0.006	0.004	0.003	0.002	0.002	0.002	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
1992	1514	0.000	0.000	0.000	0.010	0.123	0.247	0.316	0.146	0.077	0.033	0.015	0.007	0.011	0.007	0.003	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000
1993	1326	0.000	0.000	0.001	0.032	0.205	0.229	0.195	0.125	0.081	0.041	0.029	0.014	0.015	0.008	0.008	0.005	0.004	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000
1994	3350	0.000	0.000	0.000	0.008	0.091	0.202	0.236	0.147	0.105	0.068	0.042	0.028	0.023	0.013	0.011	0.008	0.005	0.004	0.002	0.002	0.001	0.001	0.001	0.001	0.000	0.000
1995	1786	0.000	0.003	0.006	0.068	0.158	0.174	0.157	0.146	0.091	0.055	0.041	0.032	0.026	0.015	0.012	0.006	0.005	0.003	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000
1996	3162	0.000	0.000	0.003	0.015	0.040	0.129	0.174	0.160	0.130	0.109	0.072	0.046	0.030	0.021	0.017	0.016	0.009	0.009	0.004	0.003	0.004	0.003	0.002	0.002	0.000	0.001
1997	1805	0.000	0.000	0.000	0.001	0.012	0.078	0.139	0.168	0.178	0.123	0.085	0.063	0.041	0.037	0.020	0.017	0.016	0.008	0.004	0.004	0.004	0.001	0.001	0.001	0.001	0.001
1998	1249	0.000	0.000	0.001	0.002	0.023	0.075	0.083	0.123	0.118	0.131	0.112	0.087	0.074	0.058	0.046	0.021	0.014	0.014	0.008	0.003	0.001	0.003	0.001	0.000	0.001	0.000
1999	735	0.000	0.000	0.000	0.011	0.050	0.102	0.090	0.120	0.158	0.129	0.076	0.080	0.054	0.031	0.031	0.022	0.016	0.007	0.008	0.001	0.003	0.001	0.005	0.003	0.000	0.000
2000	1712	0.000	0.000	0.000	0.001	0.015	0.034	0.068	0.097	0.083	0.089	0.087	0.093	0.074	0.071	0.060	0.046	0.052	0.037	0.030	0.018	0.013	0.008	0.003	0.005	0.005	0.001
2001	1369	0.000	0.000	0.000	0.000	0.007	0.026	0.058	0.091	0.099	0.088	0.096	0.101	0.077	0.077	0.079	0.047	0.037	0.030	0.028	0.016	0.016	0.009	0.007	0.004	0.004	0.001
2002	1742	0.000	0.000	0.000	0.000	0.011	0.063	0.115	0.111	0.115	0.087	0.090	0.092	0.082	0.076	0.048	0.040	0.026	0.014	0.013	0.007	0.002	0.001	0.002	0.001	0.003	0.001
2003	245	0.000	0.000	0.000	0.000	0.020	0.049	0.033	0.114	0.131	0.078	0.078	0.069	0.057	0.073	0.082	0.086	0.033	0.037	0.024	0.008	0.004	0.000	0.008	0.004	0.004	0.004
2004	457	0.002	0.004	0.002	0.002	0.022	0.028	0.061	0.101	0.105	0.127	0.147	0.144	0.055	0.046	0.039	0.024	0.013	0.009	0.022	0.013	0.011	0.002	0.009	0.002	0.004	0.002
2005	772	0.000	0.000	0.000	0.001	0.000	0.026	0.073	0.105	0.131	0.115	0.093	0.076	0.054	0.052	0.067	0.047	0.030	0.027	0.030	0.019	0.013	0.010	0.004	0.006	0.006	0.008
2006	366	0.000	0.000	0.005	0.011	0.030	0.057	0.041	0.046	0.057	0.098	0.139	0.164	0.085	0.063	0.052	0.038	0.030	0.022	0.019	0.014	0.011	0.005	0.003	0.000	0.000	0.005
2007	1240	0.000	0.000	0.001	0.006	0.007	0.028	0.054	0.098	0.095	0.092	0.081	0.085	0.082	0.071	0.079	0.055	0.045	0.027	0.024	0.011	0.009	0.013	0.010	0.006	0.010	0.003

Table 5.4B Age compositions and sample sizes of vermilion snapper caught in MARMAP chevron traps.

Age	N	0	1	2	3	4	5	6	7	8	9	10	11	12+
2002	765	0.000	0.018	0.267	0.247	0.148	0.183	0.061	0.031	0.025	0.013	0.005	0.001	0.000
2003	215	0.000	0.051	0.284	0.288	0.172	0.070	0.102	0.009	0.014	0.000	0.000	0.005	0.005
2004	305	0.000	0.010	0.102	0.325	0.203	0.161	0.069	0.072	0.033	0.007	0.007	0.007	0.007
2005	482	0.002	0.012	0.193	0.216	0.272	0.141	0.075	0.031	0.044	0.004	0.004	0.004	0.002
2006	272	0.000	0.085	0.136	0.210	0.151	0.268	0.070	0.044	0.015	0.022	0.000	0.000	0.000
2007	536	0.000	0.009	0.485	0.104	0.088	0.088	0.138	0.052	0.019	0.006	0.007	0.004	0.000

Table 5.4C Length compositions (cm) and sample sizes of vermilion snapper caught in MARMAP FL snapper traps.

LEN (cm)	N	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1983	469	0.000	0.000	0.004	0.006	0.055	0.136	0.124	0.128	0.098	0.092	0.064	0.070	0.058	0.064	0.030	0.017	0.011	0.011	0.004	0.011	0.011	0.002	0.004	0.000	0.000	0.000
1984	354	0.000	0.000	0.000	0.017	0.051	0.167	0.164	0.172	0.136	0.110	0.085	0.040	0.014	0.011	0.008	0.003	0.000	0.006	0.006	0.003	0.000	0.000	0.000	0.000	0.006	0.000
1985	608	0.000	0.000	0.002	0.013	0.056	0.141	0.160	0.166	0.122	0.095	0.113	0.051	0.028	0.026	0.007	0.005	0.003	0.003	0.003	0.000	0.002	0.000	0.000	0.003	0.000	0.000
1986	471	0.000	0.000	0.006	0.034	0.100	0.231	0.172	0.157	0.098	0.051	0.059	0.032	0.017	0.011	0.004	0.017	0.004	0.002	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
1987	290	0.000	0.003	0.007	0.062	0.121	0.193	0.186	0.138	0.103	0.066	0.024	0.024	0.021	0.007	0.010	0.017	0.007	0.000	0.003	0.000	0.003	0.003	0.000	0.000	0.000	0.000

Table 5.5. CPUE of vermilion snapper off the southeastern U.S. computed from MARMAP chevron traps. Columns are year, annual sample size (N = number of positive and zero trips), nominal CPUE (fish/trap-hr), nominal CPUE relative to its mean, standardized CPUE, and coefficient of variation (CV) of the standardized CPUE.

Year	N	Nominal CPUE	Relative nominal	Standardized CPUE	CV
1990	274	1.242	0.503	0.568	0.205
1991	278	6.962	2.819	2.541	0.175
1992	293	3.177	1.287	1.314	0.199
1993	412	1.975	0.800	1.052	0.173
1994	410	4.862	1.969	2.026	0.165
1995	388	2.774	1.123	1.069	0.177
1996	519	3.678	1.490	1.182	0.176
1997	505	1.978	0.801	0.695	0.196
1998	485	1.528	0.619	0.640	0.188
1999	254	1.710	0.693	0.883	0.212
2000	328	3.196	1.294	0.956	0.195
2001	288	2.684	1.087	0.994	0.205
2002	292	3.389	1.372	1.301	0.191
2003	280	0.504	0.204	0.605	0.262
2004	327	0.841	0.340	0.507	0.208
2005	336	1.215	0.492	0.532	0.189
2006	349	0.691	0.280	0.368	0.226
2007	390	2.042	0.827	0.769	0.203

Table 5.6. CPUE of vermilion snapper off the southeastern U.S. computed from MARMAP Florida snapper traps. Columns are year, annual sample size (N = number of positive and zero trips), nominal CPUE (fish/trap-hr), nominal CPUE relative to its mean, standardized CPUE, and coefficient of variation (CV) of the standardized CPUE.

Year	N	Nominal CPUE	Relative nominal	Standardized CPUE	CV
1983	165	1.118	1.338	1.330	0.239
1984	259	0.527	0.630	0.711	0.184
1985	260	0.942	1.127	1.179	0.195
1986	228	1.158	1.386	1.278	0.196
1987	346	0.433	0.519	0.501	0.189

Table 5.7A. Vermilion snapper: backward stepwise AIC applied to commercial logbook data from north of Cape Canaveral. Final model used for application of Stephens and MacCall.

```
Initial Model:
Vermilion.snapper ~ Speckled.hind + Rock.hind + Red.hind +
    Snowy.grouper +
    Red.grouper + Black.grouper + Gag + Scamp + Yellowfin.grouper +
    White.grunt + Margate + Black.margate + Bluestriped.grunt +
    French.grunt + Hogfish + Almaco.jack + Greater.amberjack +
    Lesser.amberjack + Banded.rudderfish + Red.porgy + Whitebone.porgy +
    Knobbed.porgy + Jolthead.porgy + Black.sea.bass + Silk.snapper +
    Gray.snapper + Mutton.snapper + Red.snapper + Yellowtail.snapper +
    Blueline.tilefish + Sand.tilefish +
    Gray.triggerfish +   Ocean.triggerfish + Queen.triggerfish

Final Model:
Vermilion.snapper ~ Speckled.hind + Rock.hind + Red.hind +
    Snowy.grouper + Red.grouper + Black.grouper +
    Gag + Scamp + Yellowfin.grouper +
    White.grunt + Margate + Black.margate + Bluestriped.grunt +
    French.grunt + Hogfish + Almaco.jack + Greater.amberjack +
    Lesser.amberjack + Banded.rudderfish + Red.porgy + Whitebone.porgy +
    Knobbed.porgy + Jolthead.porgy + Black.sea.bass + Silk.snapper +
    Gray.snapper + Mutton.snapper + Red.snapper + Yellowtail.snapper +
    Gray.triggerfish + Ocean.triggerfish + Queen.triggerfish
```

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				59631	55410.98	55480.98
2	- Blueline.tilefish	1	0.3008467	59632	55411.28	55479.28
3	- Sand.tilefish	1	1.6760002	59633	55412.96	55478.96

Table 5.7B. Vermilion snapper: backward stepwise AIC applied to commercial logbook data from south of Cape Canaveral. Final model used for application of Stephens and MacCall.

```
Vermilion.snapper ~ Blue.runner + Crevalle.jack + Snowy.grouper +
    Red.grouper + Black.grouper + Gag + Scamp + White.grunt +
    Bluestriped.grunt + French.grunt + Hogfish + Almaco.jack +
    Greater.amberjack + Red.porgy + Jolthead.porgy + Silk.snapper +
    Gray.snapper + Lane.snapper + Mutton.snapper + Red.snapper +
    Yellowtail.snapper + Tilefish + Blueline.tilefish + Gray.triggerfish

Final Model:
Vermilion.snapper ~ Crevalle.jack + Snowy.grouper + Black.grouper +
    Gag + Scamp + White.grunt + French.grunt + Hogfish + Almaco.jack +
    Greater.amberjack + Red.porgy + Jolthead.porgy + Silk.snapper +
    Lane.snapper + Mutton.snapper + Red.snapper + Yellowtail.snapper +
    Gray.triggerfish
```

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				139115	21454.93	21504.93
2	- Gray.snapper	1	0.05541852	139116	21454.98	21502.98
3	- Blueline.tilefish	1	0.06194497	139117	21455.04	21501.04
4	- Bluestriped.grunt	1	0.28023006	139118	21455.32	21499.32
5	- Red.grouper	1	0.30570823	139119	21455.63	21497.63
6	- Blue.runner	1	0.44765235	139120	21456.08	21496.08
7	- Tilefish	1	1.40189779	139121	21457.48	21495.48

Table 5.8. Number of trips by year and area (GA=Georgia, NC=North Carolina, NF=north Florida, SC=South Carolina, SF=south Florida) that caught vermilion snapper, as reported in commercial logbook data.

year	STATE					
Frequency	GA	NC	NF	SC	SF	Total
1993	186	640	442	1066	198	2532
1994	192	805	519	1250	133	2899
1995	175	891	616	1328	214	3224
1996	229	728	598	1175	194	2924
1997	159	841	490	1347	273	3110
1998	113	787	404	1323	222	2849
1999	117	727	335	1129	207	2515
2000	87	614	356	1121	216	2394
2001	149	582	371	1254	209	2565
2002	172	638	377	1133	217	2537
2003	117	417	293	958	224	2009
2004	98	332	297	931	176	1834
2005	98	382	234	970	193	1877
2006	68	395	215	1100	117	1895
2007	67	481	320	1179	123	2170
Total	2027	9260	5867	17264	2916	37334

Table 5.9. CPUE of vermilion snapper off the southeastern U.S. based on handline gear reported in commercial logbooks. Columns are year, annual sample size (N = number of positive and zero trips selected by the Stephens and MacCall method), nominal CPUE (lb/hook-hr), nominal CPUE relative to its mean, standardized CPUE, and coefficient of variation (CV) of the standardized CPUE.

Year	N	Nominal CPUE	Relative nominal	Standardized CPUE	CV
1993	2828	0.870	0.519	0.524	0.044
1994	3103	1.077	0.643	0.617	0.048
1995	3432	1.038	0.619	0.644	0.046
1996	3002	0.882	0.526	0.534	0.032
1997	3203	1.043	0.622	0.634	0.031
1998	2931	1.268	0.757	0.717	0.044
1999	2570	1.728	1.031	1.043	0.047
2000	2451	2.470	1.473	1.487	0.038
2001	2771	2.283	1.362	1.406	0.031
2002	2762	2.095	1.250	1.269	0.037
2003	2189	1.491	0.890	0.854	0.041
2004	2035	2.721	1.623	1.634	0.097
2005	1954	2.306	1.375	1.416	0.055
2006	1985	1.724	1.028	0.995	0.044
2007	2430	2.151	1.283	1.227	0.042

Table 5.10. Proportion of vermilion snapper trips from the headboat fishery that exceeded 10 vermilion snapper per angler. Starting in 1992, regulations allowed no more than 10 vermilion snapper per angler per day.

Proportion of trips with catch/angler>10 fish					
year	area				
Frequency	NC	NF	SC	SF	Total
1973	0.006	NA	0.117	NA	0.043
1974	0.005	NA	0.011	NA	0.008
1975	0.017	NA	0.034	NA	0.026
1976	0.003	0.060	0.014	NA	0.030
1977	0.021	0.054	0.003	NA	0.036
1978	0.000	0.069	0.026	0.000	0.047
1979	0.016	0.074	0.000	0.008	0.046
1980	0.020	0.049	0.006	0.002	0.025
1981	0.066	0.035	0.029	0.003	0.022
1982	0.056	0.019	0.041	0.004	0.020
1983	0.021	0.026	0.009	0.001	0.011
1984	0.019	0.019	0.044	0.002	0.014
1985	0.040	0.039	0.069	0.001	0.023
1986	0.038	0.047	0.073	0.002	0.029
1987	0.014	0.047	0.065	0.020	0.036
1988	0.038	0.083	0.069	0.009	0.050
1989	0.022	0.054	0.094	0.003	0.035
1990	0.085	0.044	0.068	0.002	0.028
1991	0.079	0.024	0.100	0.002	0.034
1992	0.015	0.000	0.056	0.002	0.011
1993	0.014	0.001	0.044	0.001	0.012
1994	0.039	0.006	0.106	0.000	0.036
1995	0.023	0.003	0.067	0.000	0.022
1996	0.034	0.003	0.079	0.000	0.030
1997	0.033	0.011	0.045	0.000	0.024
1998	0.049	0.023	0.060	0.000	0.034
1999	0.032	0.020	0.053	0.000	0.028
2000	0.023	0.085	0.049	0.000	0.052
2001	0.030	0.047	0.052	0.000	0.038
2002	0.031	0.091	0.043	0.000	0.058
2003	0.012	0.026	0.013	0.000	0.018
2004	0.030	0.044	0.014	0.000	0.028
2005	0.024	0.058	0.052	0.000	0.043
2006	0.016	0.045	0.017	0.000	0.032
2007	0.013	0.015	0.013	0.000	0.014
Total	0.026	0.041	0.048	0.004	0.029

Table 5.11A. Vermilion snapper: backward stepwise AIC applied to headboat data from north of Cape Canaveral. Final model used for application of Stephens and MacCall.

```
Initial Model:
Vermilion_snapper ~ Gag + Gray_triggerfish + Greater_amberjack +
    Knobbed_porgy + Red_porgy + Red_snapper + Speckled_Hind +
    White_grunt + Warsaw_Grouper + Black_sea_bass + Snowy_Grouper +
    Tomtate + Gray_snapper + Scamp + Red_Grouper + Whitebone_porgy +
    Lane_snapper + Atlantic_spadefish + Yellowtail_snapper +
    Rock_Hind + Longspine_porgy + Red_Hind + Mutton_snapper +
    Almaco_jack + Queen_triggerfish + Graysby + Jolthead_porgy +
    Cubera_snapper + Blue_runner + Scup + Bank_sea_bass
    + Banded_rudderfish

Final Model:
Vermilion_snapper ~ Gag + Gray_triggerfish + Greater_amberjack +
    Knobbed_porgy + Red_porgy + Red_snapper + Speckled_Hind +
    White_grunt + Warsaw_Grouper + Black_sea_bass + Snowy_Grouper +
    Tomtate + Gray_snapper + Scamp + Red_Grouper + Whitebone_porgy +
    Lane_snapper + Atlantic_spadefish + Yellowtail_snapper +
    Rock_Hind + Longspine_porgy + Red_Hind +
    Almaco_jack + Queen_triggerfish + Graysby +    Jolthead_porgy +
    Cubera_snapper + Blue_runner +
    Scup + Bank_sea_bass + Banded_rudderfish
```

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				131975	127528.2	127594.2
2	- Mutton_snapper	1	1.107174	131976	127529.3	127593.3

Table 5.11B. Vermilion snapper: backward stepwise AIC applied to headboat data from south of Cape Canaveral. Final model used for application of Stephens and MacCall.

```
Initial Model:
Vermilion_snapper ~ Yellowtail_snapper + Black_Grouper +
    Mutton_snapper +
    Tomtate + White_grunt + Bluestriped_grunt + Gray_snapper +
    Gray_triggerfish + Red_Hind + Red_porgy + Hogfish + Jolthead_porgy +
    Lane_snapper + Red_Grouper + Knobbed_porgy + Whitebone_porgy +
    Margate + Red_snapper + Rock_Hind + Queen_triggerfish +
    Blue_runner +
    Gag + Porkfish + Scamp + Silk_snapper + Schoolmaster +
    Greater_amberjack +
    Black_sea_bass + Ocean_triggerfish + Graysby + Bar_jack +
    Blackfin_snapper + Sand_tilefish + French_grunt + Saucereye_porgy +
    Black_margate + Almaco_jack

Final Model:
Vermilion_snapper ~ Yellowtail_snapper + Black_Grouper +
    Mutton_snapper +
    Tomtate + White_grunt + Bluestriped_grunt + Gray_snapper +
    Gray_triggerfish + Red_Hind + Red_porgy + Hogfish + Jolthead_porgy +
    Lane_snapper + Red_Grouper + Knobbed_porgy + Whitebone_porgy +
    Red_snapper + Rock_Hind + Queen_triggerfish + Blue_runner +
    Gag + Porkfish + Scamp + Silk_snapper + Schoolmaster +
    Greater_amberjack +
    Black_sea_bass + Ocean_triggerfish + Bar_jack + Blackfin_snapper +
    Sand_tilefish + French_grunt + Saucereye_porgy + Black_margate +
    Almaco_jack


       Step Df  Deviance Resid. Df Resid. Dev      AIC
1                           145216   108825.0 108901.0
2 - Margate  1 0.1665179    145217   108825.2 108899.2
3 - Graysby  1 0.8435152    145218   108826.1 108898.1
```

Table 5.12. Number of trips by year and area (NC=North Carolina, NF=Georgia and north Florida, SC=South Carolina, SF=south Florida) that caught vermilion snapper, as reported in headboat data.

year	AREA				
Frequency	NC	NF	SC	SF	Total
1973	353	0	179	0	532
1974	420	0	453	0	873
1975	484	0	586	0	1070
1976	350	637	580	0	1567
1977	142	830	386	0	1358
1978	256	1400	392	231	2279
1979	243	1319	154	629	2345
1980	148	1458	363	1188	3157
1981	122	1139	208	1115	2584
1982	270	1063	462	1095	2890
1983	238	1316	546	2092	4192
1984	156	1295	405	1651	3507
1985	125	1295	480	2068	3968
1986	157	1891	490	2053	4591
1987	208	1832	651	2198	4889
1988	237	1643	710	1589	4179
1989	93	1396	351	1481	3321
1990	118	1085	428	1575	3206
1991	280	908	478	1078	2744
1992	476	1146	551	1394	3567
1993	414	1110	637	944	3105
1994	409	710	611	608	2338
1995	480	698	608	707	2493
1996	496	613	593	485	2187
1997	306	379	493	347	1525
1998	447	690	665	472	2274
1999	379	950	621	303	2253
2000	393	719	701	198	2011
2001	331	914	522	328	2095
2002	327	919	488	242	1976
2003	259	909	378	200	1746
2004	367	1171	492	402	2432
2005	253	924	329	276	1782
2006	247	1097	471	115	1930
2007	233	1061	520	51	1865
Total	10217	34517	16982	27115	88831

Table 5.13. CPUE of vermilion snapper off the southeastern U.S. based on headboat data. Columns are year, annual sample size (N = number of positive and zero trips selected by the Stephens and MacCall method), nominal CPUE (fish/angler-hr), nominal CPUE relative to its mean, standardized CPUE, and coefficient of variation (CV) of the standardized CPUE.

Year	N	Nominal CPUE	Relative nominal	Standardized CPUE	CV
1976	1536	0.233	1.512	1.252	0.038
1977	1790	0.215	1.391	1.064	0.041
1978	2678	0.281	1.819	1.639	0.032
1979	2484	0.212	1.377	1.569	0.036
1980	2908	0.112	0.728	0.899	0.042
1981	2501	0.112	0.724	1.027	0.044
1982	2610	0.098	0.633	0.882	0.042
1983	3412	0.133	0.859	1.319	0.031
1984	3052	0.123	0.797	1.090	0.035
1985	4048	0.139	0.903	1.319	0.032
1986	4879	0.120	0.781	1.081	0.030
1987	4714	0.155	1.006	1.340	0.030
1988	4062	0.181	1.172	1.431	0.028
1989	3082	0.141	0.914	1.140	0.038
1990	3170	0.137	0.890	1.147	0.036
1991	2861	0.143	0.926	1.066	0.038
1992	3776	0.085	0.548	0.498	0.046
1993	3069	0.090	0.585	0.500	0.047
1994	2802	0.107	0.693	0.497	0.050
1995	3080	0.098	0.635	0.536	0.050
1996	2403	0.123	0.796	0.586	0.049
1997	1702	0.146	0.944	0.826	0.053
1998	2679	0.138	0.895	0.688	0.045
1999	2153	0.156	1.014	0.803	0.045
2000	1923	0.205	1.330	0.991	0.046
2001	2127	0.196	1.268	1.063	0.043
2002	1861	0.220	1.426	1.171	0.043
2003	1734	0.141	0.915	0.744	0.055
2004	2285	0.179	1.160	1.033	0.039
2005	1718	0.168	1.086	0.941	0.049
2006	1706	0.183	1.189	0.990	0.043
2007	1762	0.168	1.088	0.866	0.046

Table 5.14. Number of intercepts from MRFSS that caught vermilion snapper or reported vermilion snapper as a targeted species. The index of abundance was computed for 1987–2007, because of sampling intensity and distribution across states.

Year	State	DIRECTED TRIPS (expanded by effort)	Effort Estimate of Trips	Number of Trips Sampled (Intercepted)	Number Interviewed Trips
1982	Total	72,956	626,128	535	60
	FL	18,478	531,881	436	16
	GA	15,054	17,370	15	13
	NC	—	—	—	—
	SC	39,424	76,877	84	31
1983	Total	78,041	1,390,161	1,249	70
	FL	31,642	949,983	1,085	54
	GA	—	—	—	—
	NC	44,593	420,445	66	7
	SC	1,806	19,734	98	9
1984	Total	70,773	949,090	1,920	247
	FL	41,016	832,356	1,503	133
	GA	—	—	—	—
	NC	—	—	—	—
	SC	29,757	116,735	417	114
1985	Total	126,123	1,485,633	1,191	149
	FL	98,704	1,400,108	876	100
	GA	1,746	14,000	152	18
	NC	—	—	—	—
	SC	25,673	71,525	163	31
1986	Total	26,582	1,155,202	893	38
	FL	23,650	1,124,305	688	15
	GA	2,219	14,152	158	21
	NC	—	—	—	—
	SC	713	16,745	47	2
1987	Total	28,495	1,139,553	3,343	84
	FL	20,074	789,663	437	10
	GA	1,309	19,099	102	7
	NC	4,622	277,392	2,216	42
	SC	2,490	53,398	588	25
1988	Total	47,852	1,793,350	4,015	205
	FL	16,410	1,310,818	1,046	13
	GA	2,127	9,355	18	4
	NC	16,570	261,348	1,992	123
	SC	12,745	211,829	959	65
1989	Total	79,130	2,808,512	5,279	330
	FL	43,873	2,330,680	1,358	24
	GA	1,470	3,551	21	9
	NC	14,865	317,954	3,165	199
	SC	18,922	156,327	735	98
1990	Total	27,109	2,087,368	4,883	209
	FL	17,328	1,776,909	1,262	13
	GA	NULL	NULL	24	10
	NC	8,981	305,980	3,470	169
	SC	800	4,479	127	17
1991	Total	37,607	2,031,971	5,022	189
	FL	23,676	1,694,569	1,307	18
	GA	1,888	7,821	40	14
	NC	6,971	293,822	3,534	138
	SC	5,072	35,758	141	19
1992	Total	38,266	2,069,799	6,889	550
	FL	9,511	1,569,660	2,535	24
	GA	4,791	33,993	427	156
	NC	13,302	379,307	3,667	343
	SC	10,662	86,838	260	27
1993	Total	39,485	3,274,350	7,184	234
	FL	22,267	3,008,535	4,077	32
	GA	5,049	10,483	151	76
	NC	7,572	232,347	2,926	120
	SC	4,597	22,985	30	6
1994	Total	49,054	3,172,651	8,865	391
	FL	26,512	2,770,811	3,524	33
	GA	5,718	17,343	153	64
	NC	15,242	362,345	5,146	291
	SC	1,582	22,152	42	3

1995	Total	54,522	2,183,356	6,370	277
	FL	19,521	1,760,623	2,095	24
	GA	12,530	20,991	152	89
	NC	10,310	360,390	4,052	145
	SC	12,161	41,352	71	19
1996	Total	23,406	920,519	5,247	211
	FL	2,276	618,908	848	3
	GA	10,264	38,424	214	71
	NC	5,599	215,816	4,037	115
	SC	5,267	47,371	148	22
1997	Total	46,284	2,276,859	7,364	195
	FL	19,293	1,720,971	2,284	29
	GA	3,041	15,624	150	45
	NC	8,482	391,861	4,452	63
	SC	15,468	148,403	478	58
1998	Total	41,649	2,353,929	7,867	244
	FL	21,065	2,001,378	4,094	47
	GA	3,011	7,120	188	86
	NC	2,485	167,772	2,998	43
	SC	15,088	177,659	587	68
1999	Total	88,295	2,766,720	9,306	374
	FL	69,561	2,584,012	6,875	205
	GA	1,334	4,510	95	24
	NC	4,734	114,714	2,001	71
	SC	12,666	63,484	335	74
2000	Total	101,621	3,595,061	10,057	445
	FL	84,290	3,064,243	6,445	209
	GA	341	1,136	59	20
	NC	2,096	306,378	2,438	27
	SC	14,894	223,304	1,115	189
2001	Total	84,451	3,573,380	11,004	531
	FL	65,819	2,981,819	7,433	290
	GA	1,178	1,610	89	65
	NC	6,112	489,397	3,130	67
	SC	11,342	100,553	352	109
2002	Total	74,484	3,169,187	10,973	544
	FL	57,739	2,769,278	7,951	346
	GA	2,581	65,313	285	48
	NC	10,088	277,150	2,578	113
	SC	4,076	57,447	159	37
2003	Total	83,679	3,628,516	9,593	629
	FL	67,580	3,429,850	7,884	353
	GA	3,535	5,341	295	195
	NC	3,837	148,819	1,274	38
	SC	8,727	44,506	140	43
2004	Total	86,556	4,077,753	10,784	759
	FL	48,795	3,500,173	7,712	272
	GA	10,264	25,719	446	268
	NC	17,878	525,124	2,320	88
	SC	9,619	26,738	306	131
2005	Total	66,098	4,100,802	9,302	391
	FL	45,771	3,628,854	7,228	176
	GA	6,153	11,829	227	109
	NC	11,467	443,517	1,554	50
	SC	2,707	16,602	293	56
2006	Total	71,845	4,481,283	11,222	570
	FL	55,108	4,243,957	8,796	222
	GA	7,802	12,084	352	229
	NC	3,689	198,347	1,754	42
	SC	5,246	26,893	320	77
2007	Total	145,460	6,799,736	11,046	560
	FL	91,245	5,912,142	8,053	283
	GA	8,985	26,089	161	75
	NC	13,494	671,083	2,393	91
	SC	31,736	190,422	439	111

Table 5.15. Proportion of vermilion snapper trips from MRFSS data that exceeded or equaled 10 vermilion snapper per angler. Starting in 1992, regulations allowed no more than 10 vermilion snapper per angler per day.

Year	Proportion trips >10 fish/angler	Proportion trips =10 fish/angler
1982	0.13	0.06
1983	0.17	0.00
1984	0.11	0.00
1985	0.13	0.14
1986	0.01	0.00
1987	0.06	0.01
1988	0.00	0.14
1989	0.06	0.08
1990	0.12	0.00
1991	0.16	0.00
1992	0.01	0.01
1993	0.05	0.04
1994	0.02	0.00
1995	0.00	0.00
1996	0.05	0.01
1997	0.01	0.01
1998	0.01	0.00
1999	0.00	0.01
2000	0.01	0.03
2001	0.06	0.04
2002	0.05	0.01
2003	0.03	0.04
2004	0.05	0.08
2005	0.04	0.05
2006	0.05	0.08
2007	0.01	0.01

Table 5.16. CPUE of vermilion snapper off the southeastern U.S. based on MRFSS data. Scaled CPUE is CPUE standardized to its mean. Totcatch CPUE is based on all catches (A+B1+B2 fish), and Harvest CPUE excludes fish discarded alive (excludes B2 fish).

Year	Totcatch CPUE	Scaled Totcatch CPUE	Total Catch PSE	Directed TotCatch Interviews	Harvest CPUE	Scaled Harvest CPUE	Harvest PSE	Directed Harvest Interviews
1987	4.57	1.17	36.2	84	4.53	1.47	37.1	81
1988	3.14	0.80	23.4	205	2.96	0.96	24.1	199
1989	3.71	0.95	19.7	330	3.41	1.11	23	313
1990	7.02	1.79	30.4	209	5.63	1.83	35	204
1991	5.67	1.45	24.7	189	5.59	1.81	29.5	183
1992	3.59	0.92	19.4	550	2.4	0.78	15.3	523
1993	3.52	0.90	17	234	3.05	0.99	19.5	220
1994	2.43	0.62	13.2	391	1.85	0.60	16.2	339
1995	3.13	0.80	23.6	277	1.36	0.44	18.5	236
1996	4.52	1.15	23.6	211	3.94	1.28	28.9	172
1997	2.56	0.65	18.1	195	2.05	0.67	17.8	186
1998	3.40	0.87	14.7	244	3.16	1.03	20.8	208
1999	4.30	1.10	11.2	374	2.27	0.74	15.9	295
2000	4.29	1.09	12.2	445	2.87	0.93	19.3	368
2001	4.04	1.03	11.1	531	3.25	1.06	15.3	450
2002	3.43	0.87	11.8	544	2.52	0.82	16.3	478
2003	4.12	1.05	12.6	629	2.61	0.85	16.6	537
2004	4.43	1.13	11.4	759	3.29	1.07	14.3	678
2005	3.60	0.92	12.2	391	2.88	0.93	16.1	348
2006	3.61	0.92	18.5	570	2.92	0.95	18.7	496
2007	3.29	0.84	9.7	560	2.15	0.70	12.9	469

Table 5.17. Pearson correlation between indices. Values in parentheses are p-values from a t-test of H_0: $\rho = 0$.

	Headboat	Commercial	MRFSS	Chevron trap	FL trap
Headboat	1	0.89 (<0.001)	0.35 (0.12)	-0.17 (0.49)	0.05 (0.93)
Commercial		1	0.36 (0.19)	-0.39 (0.15)	NA
MRFSS			1	0.03 (0.90)	NA
Chevron trap				1	NA
FL trap					1

5.9 FIGURES

Figure 5.1. Sampling locations of MARMAP chevron traps.

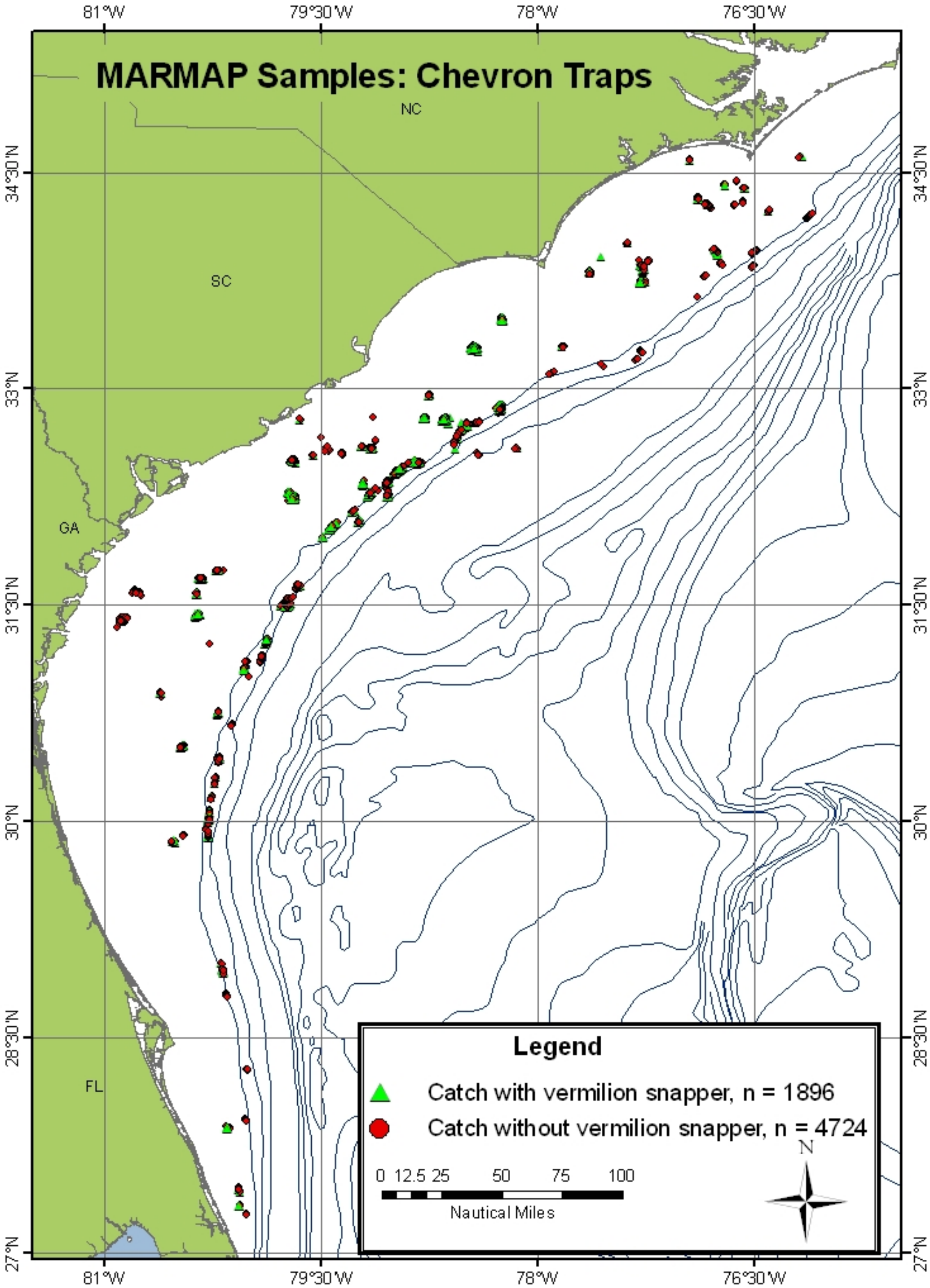


Figure 5.2. Vermilion snapper: index of abundance (plus/minus two SE) from MARMAP chevron trap data. Index is scaled to its mean.

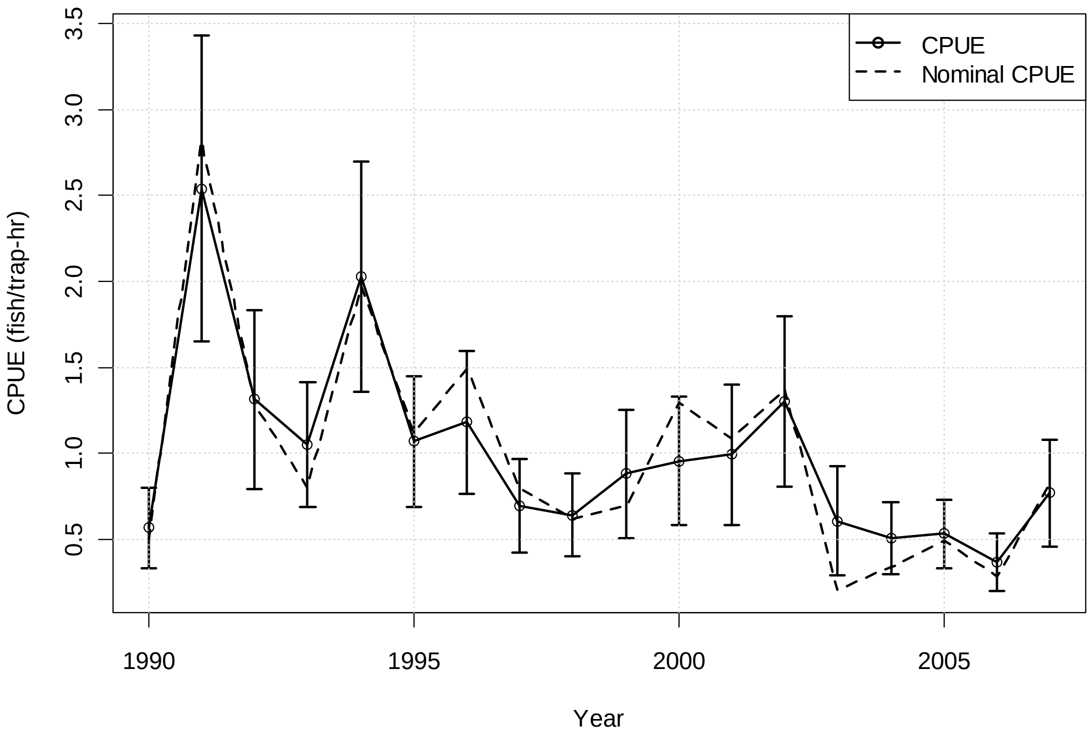


Figure 5.3. Sampling locations of MARMAP Florida snapper traps.

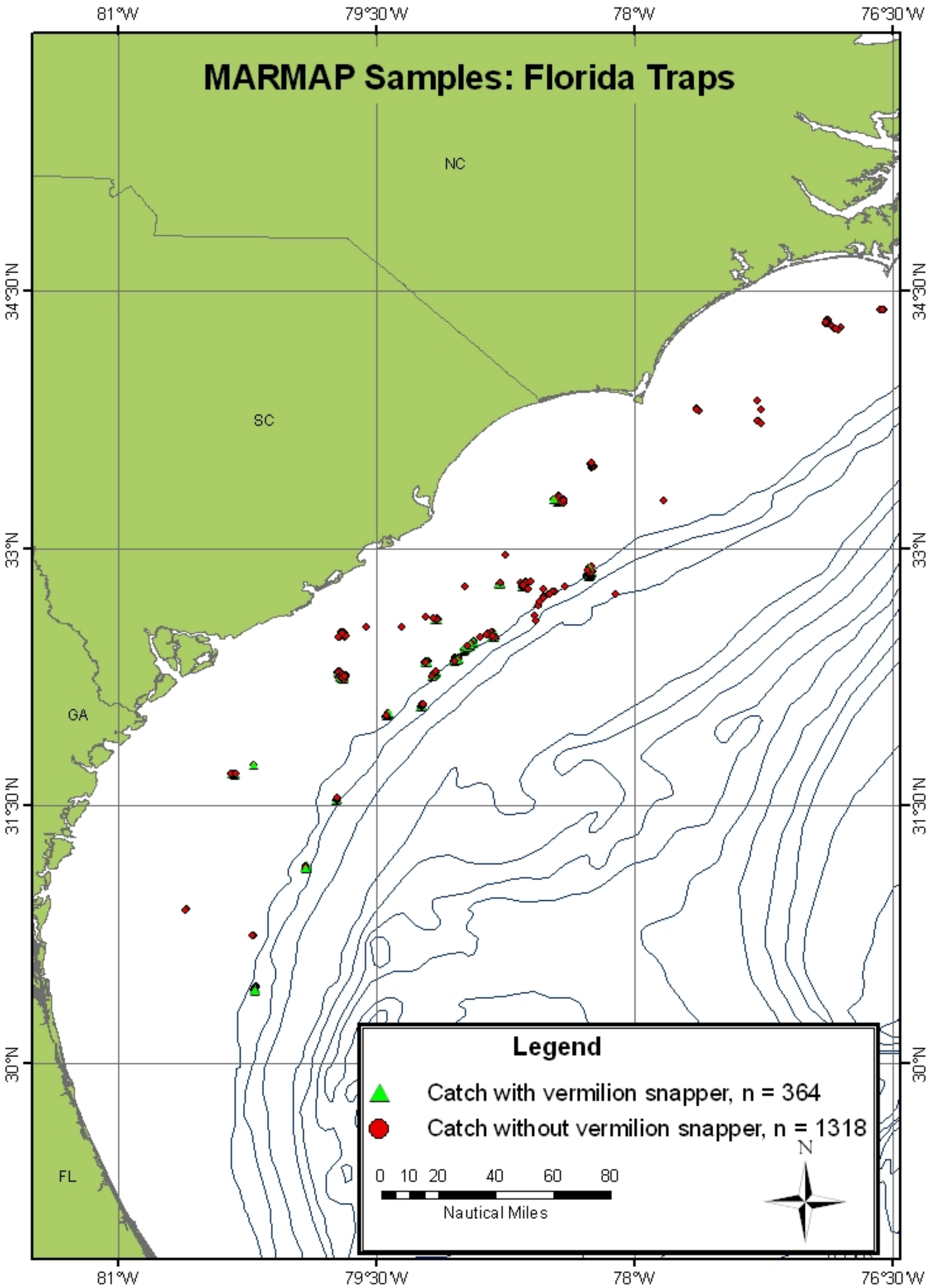


Figure 5.4. Vermilion snapper: index of abundance (plus/minus two SE) from MARMAP Florida snapper trap. Index is data scaled to its mean.

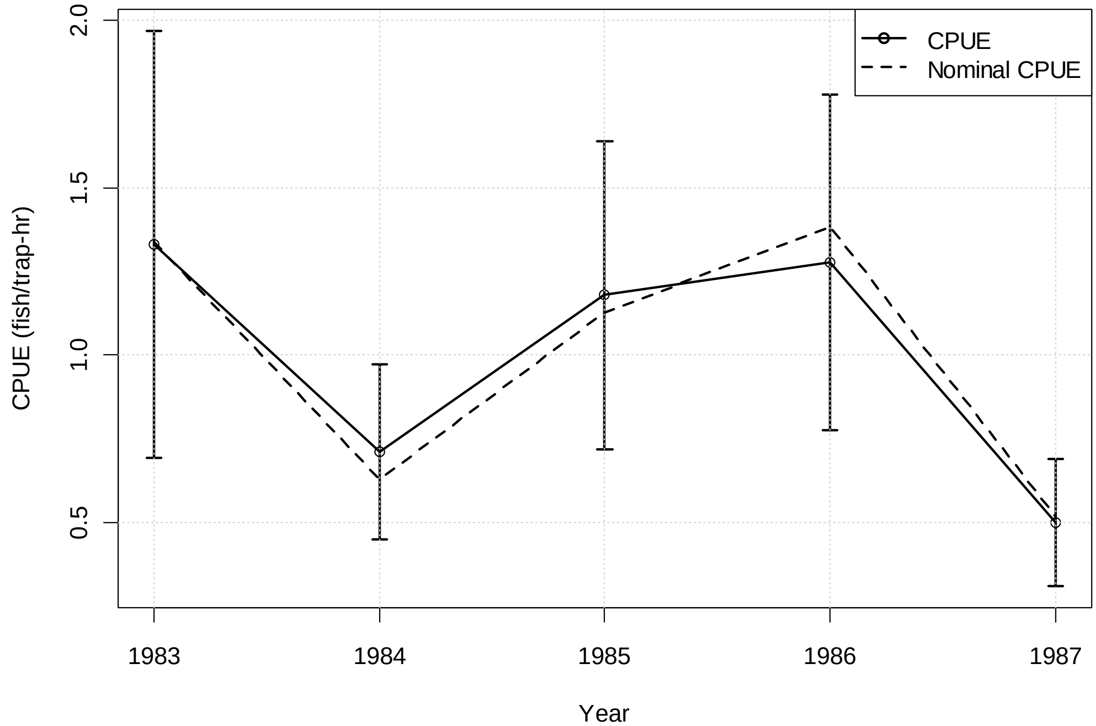


Figure 5.5. Areas reported in commercial logbooks. First two digits signify degrees latitude, second two degrees longitude. Areas were excluded from the analysis if north of 36 degrees latitude or if in the Gulf of Mexico (codes=1, 2, 3,…). Areas were considered southern Florida at 28 degrees latitude and south (break near Cape Canaveral).

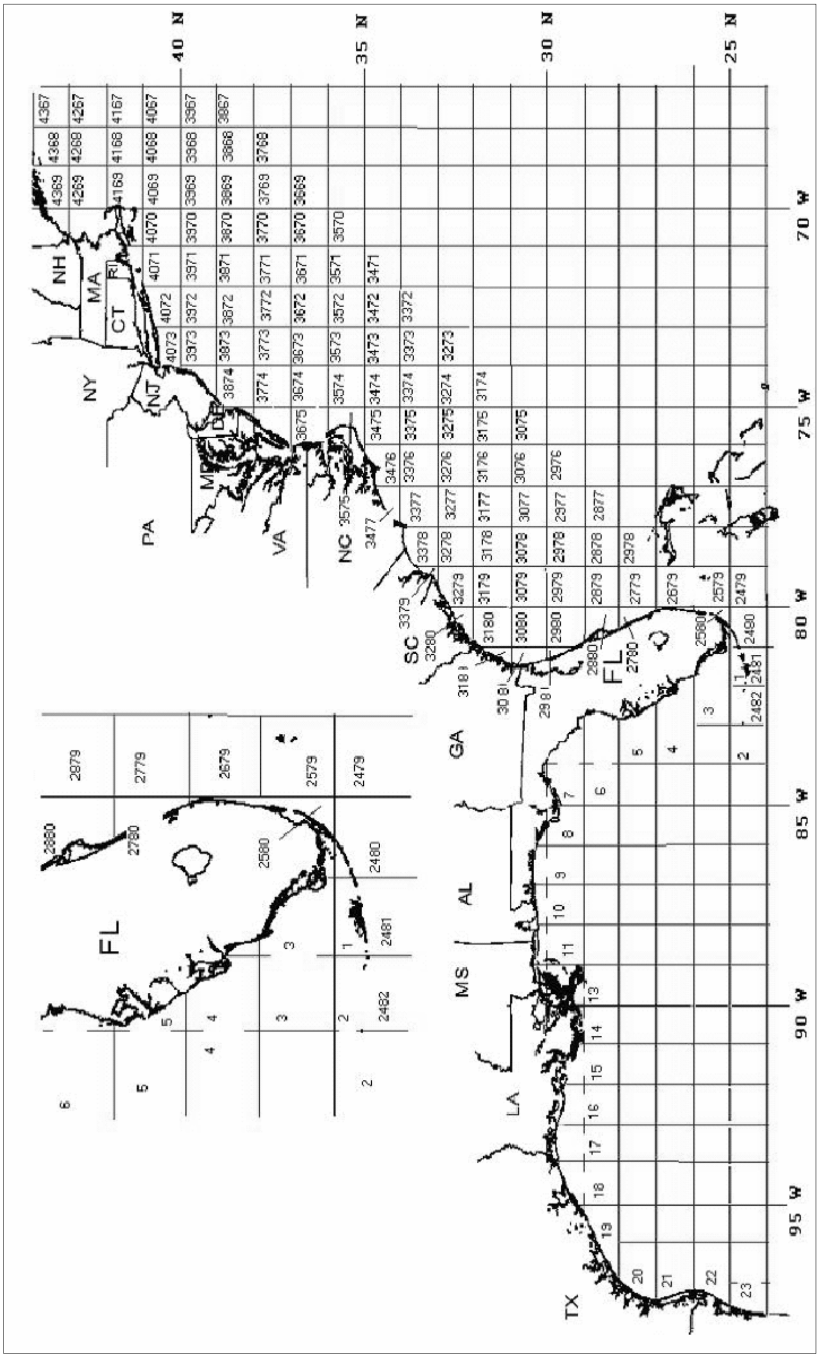


Figure 5.6A. Estimates of species-specific regression coefficients from Stephens and MacCall method applied to commercial logbook data from north of Cape Canaveral, as used to estimate each trip's probability of catching the focal species.

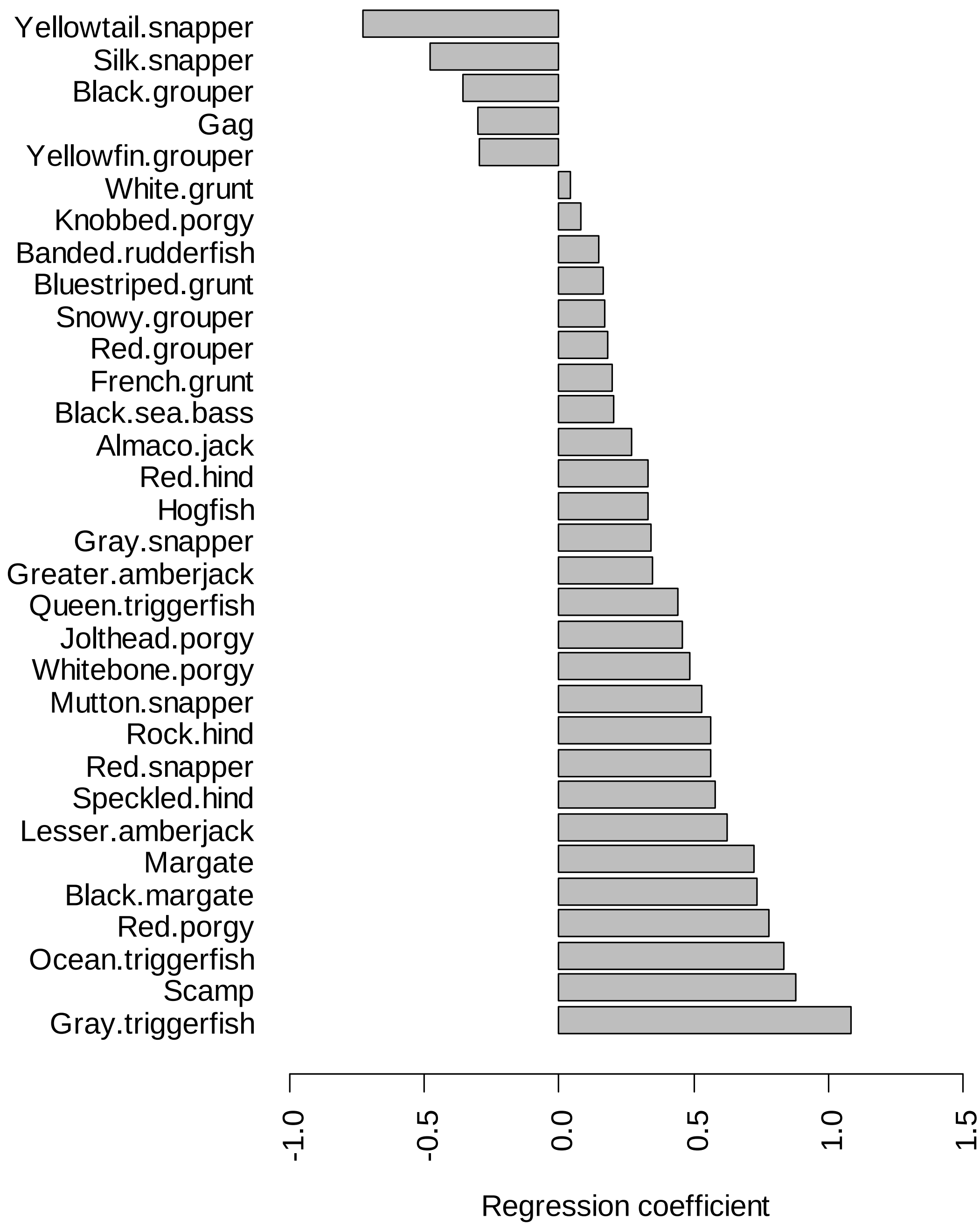


Figure 5.6B. Estimates of species-specific regression coefficients from Stephens and MacCall method applied to commercial logbook data from south of Cape Canaveral, as used to estimate each trip's probability of catching the focal species.

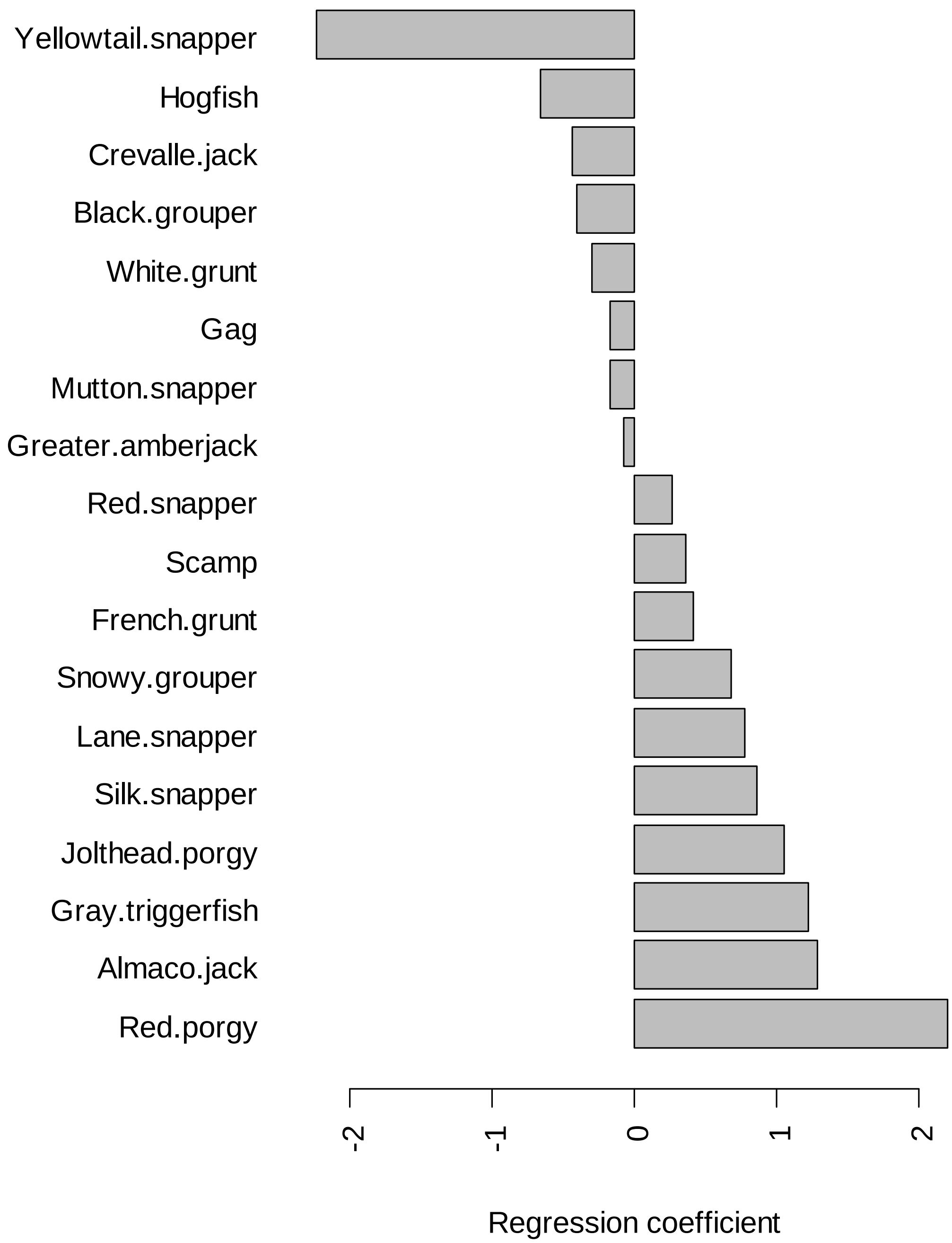


Figure 5.7A. Absolute difference between observed and predicted number of positive trips from Stephens and MacCall method applied to commercial logbook data from north of Cape Canaveral. Left and right panels differ only in the range of probabilities shown.

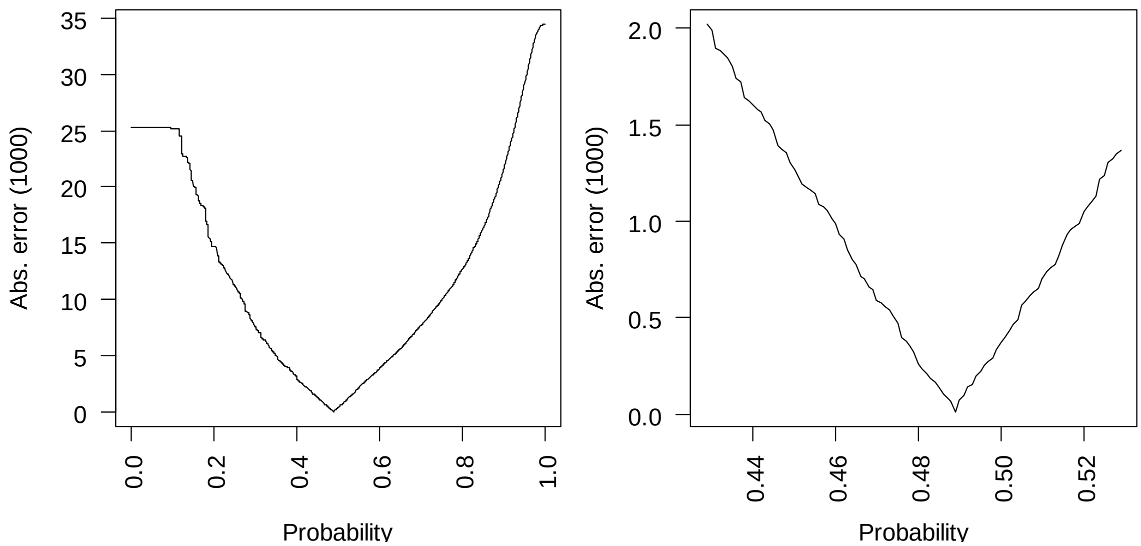


Figure 5.7B. Absolute difference between observed and predicted number of positive trips from Stephens and MacCall method applied to commercial logbook data from south of Cape Canaveral. Left and right panels differ only in the range of probabilities shown.

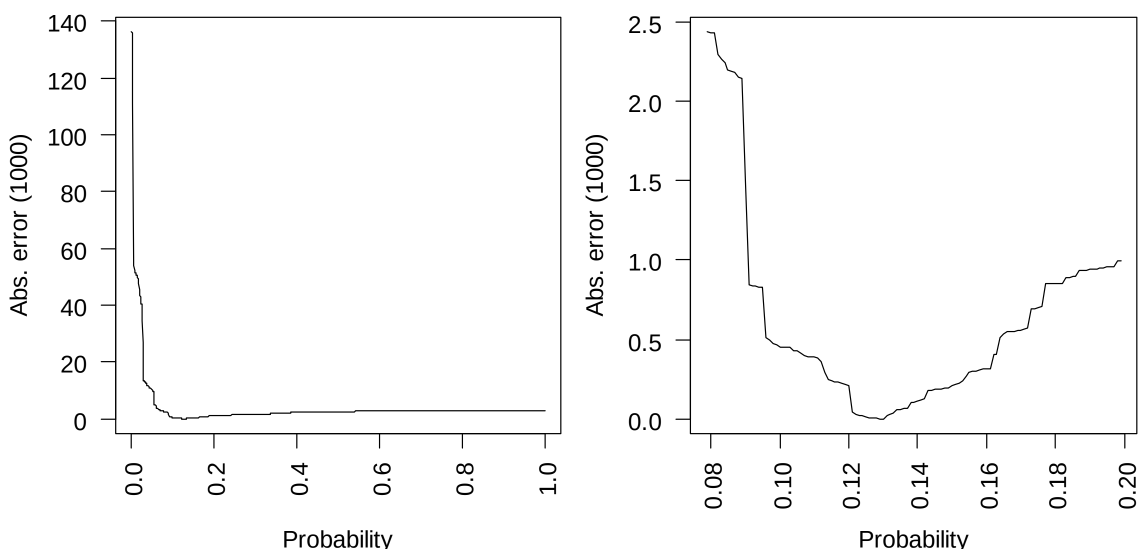


Figure 5.8. Vermilion snapper: index of abundance (plus/minus two SE) from commercial logbook data. Index is scaled to its mean.

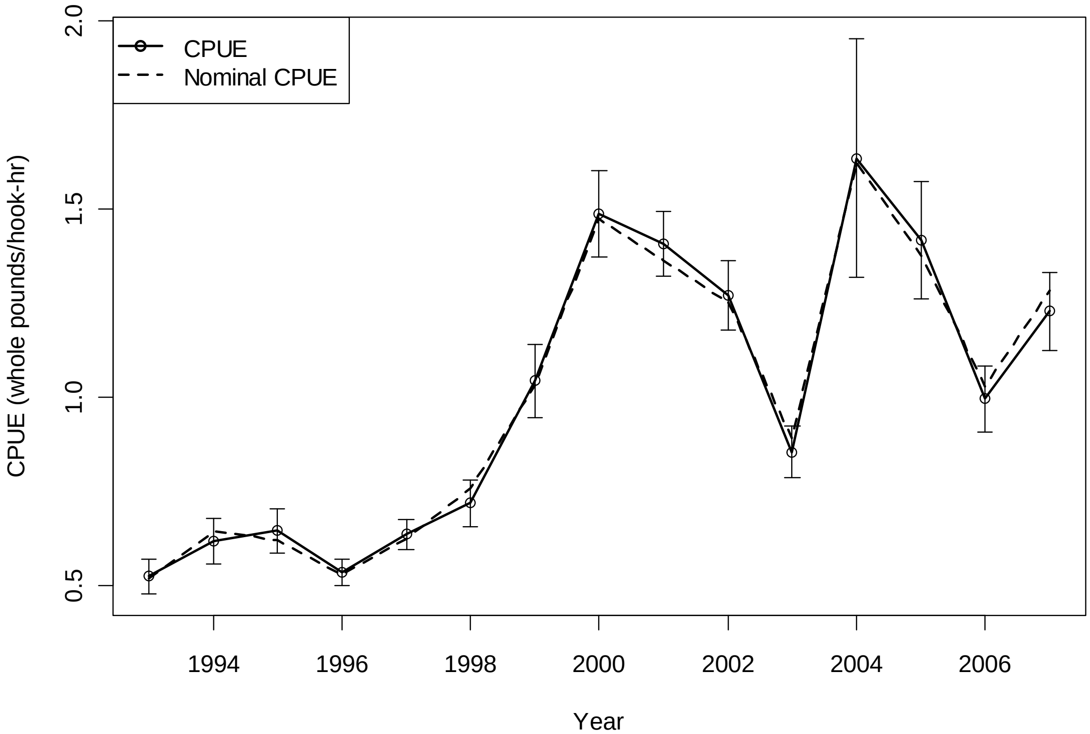


Figure 5.9. Areas from the headboat survey. Areas 11, 12, and 17 were considered southern Florida (break near Cape Canaveral).

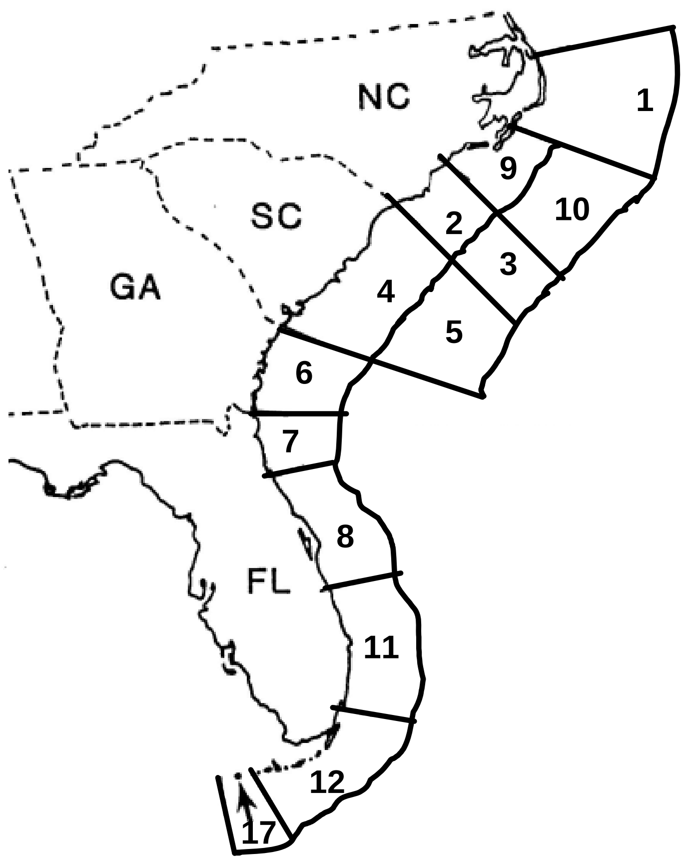


Figure 5.10A. Estimates of species-specific regression coefficients from Stephens and MacCall method applied to headboat data from areas in the northern region (excludes areas 11, 12, 17), as used to estimate each trip's probability of catching the focal species.

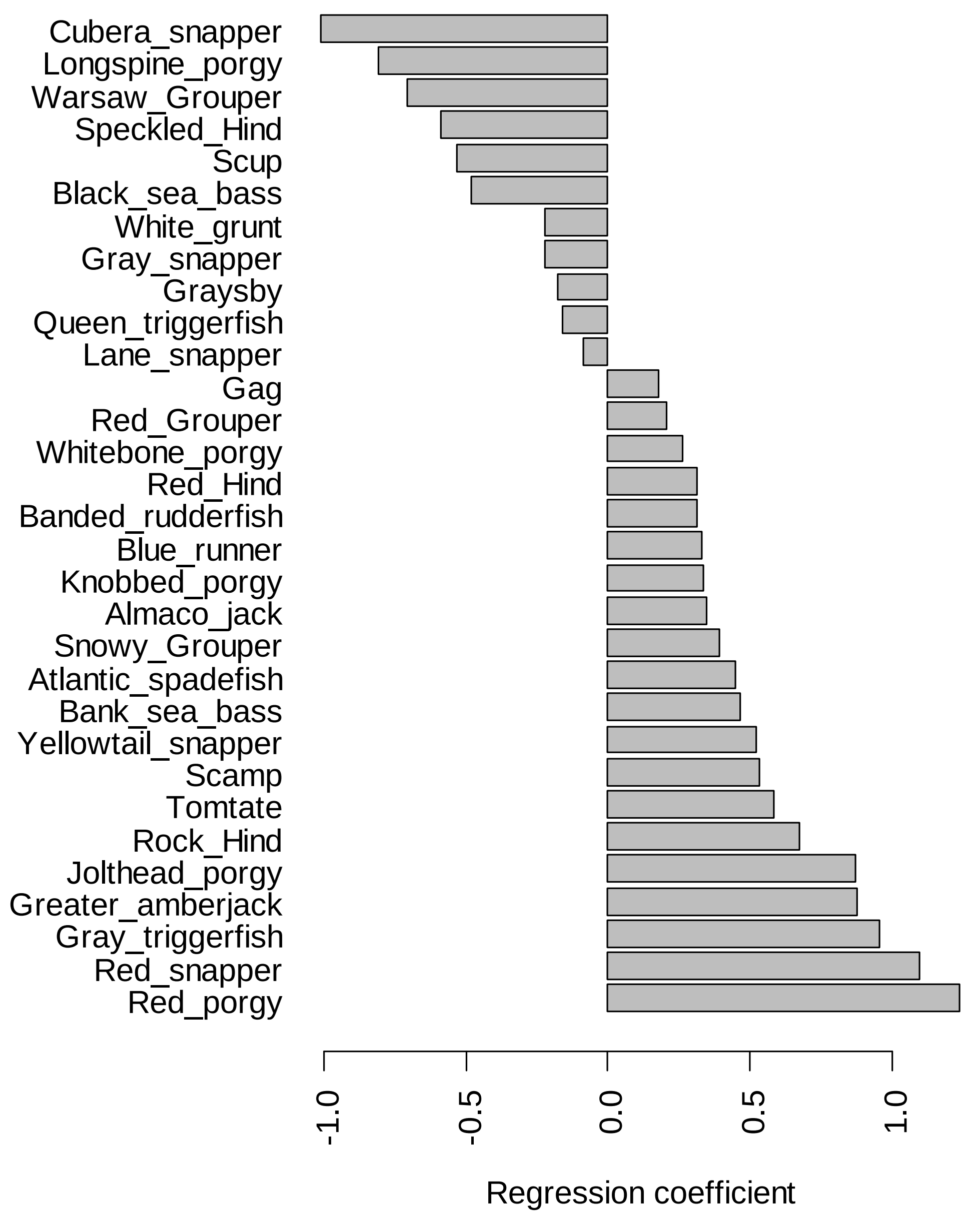


Figure 5.10B. Estimates of species-specific regression coefficients from Stephens and MacCall method applied to headboat data from areas in the southern region (areas 11, 12, 17), as used to estimate each trip's probability of catching the focal species.

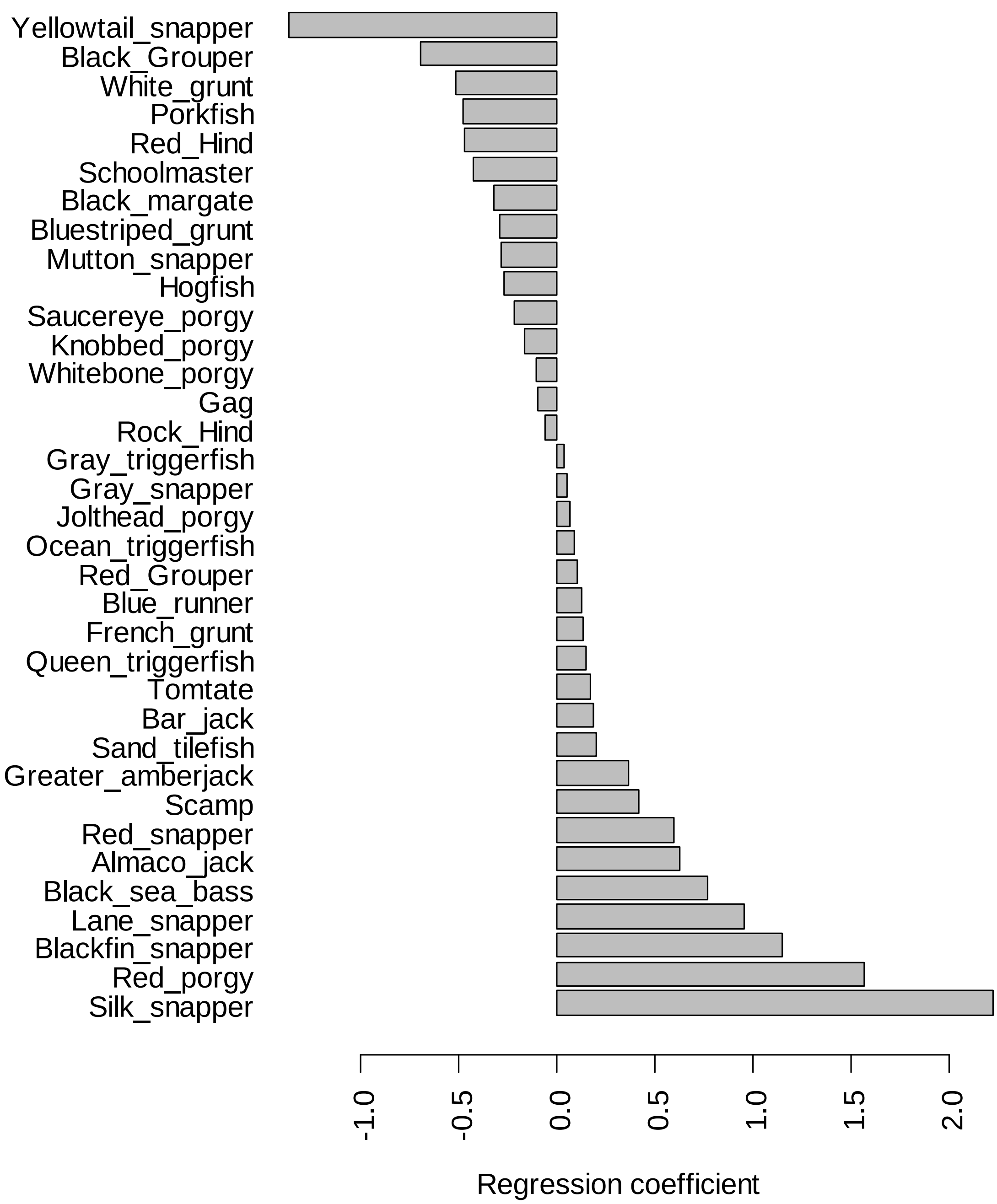


Figure 5.11A. Absolute difference between observed and predicted number of positive trips from Stephens and MacCall method applied to headboat data from the northern region (excludes areas 11, 12, 17). Left and right panels differ only in the range of probabilities shown.

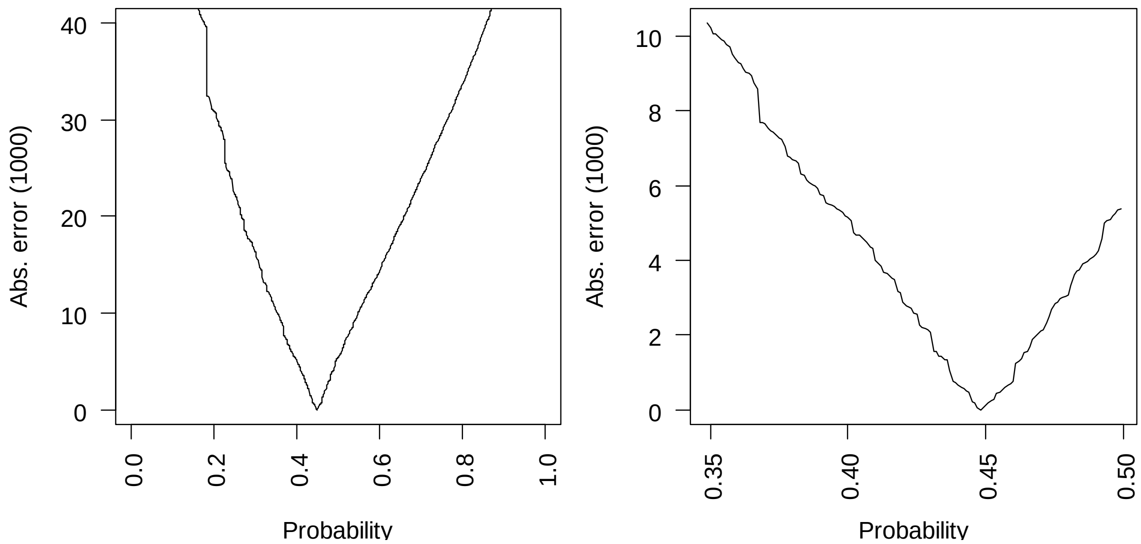


Figure 5.11B. Absolute difference between observed and predicted number of positive trips from Stephens and MacCall method applied to headboat data from the southern region (areas 11, 12, 17). Left and right panels differ only in the range of probabilities shown.

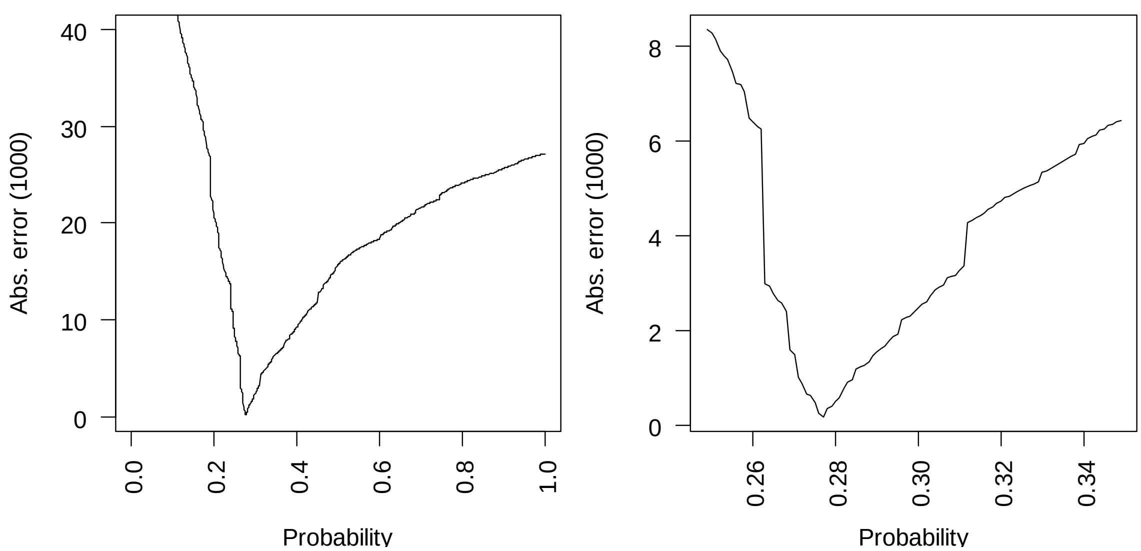


Figure 5.12. Vermilion snapper: index of abundance (plus/minus two SE) from headboat data. Index is scaled to its mean.

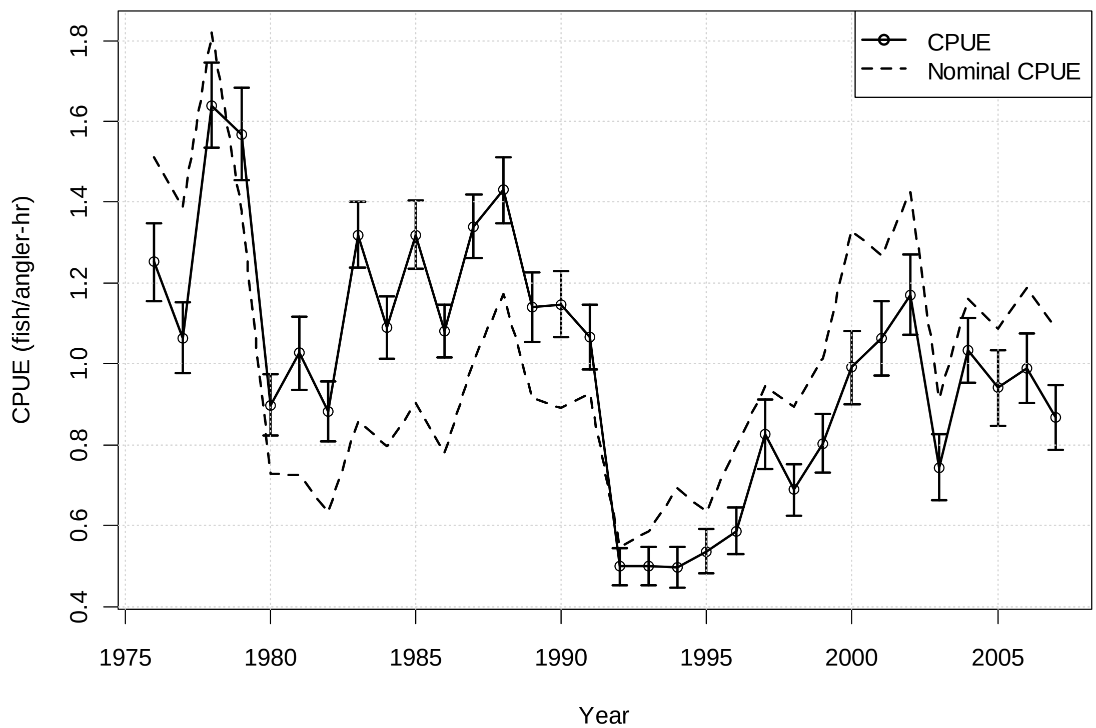


Figure 5.13. Counties sampled by the MRFSS, as used to compute the index of abundance, included those along the coast from Currituck County, NC through Miami-Dade County, FL.

Figure 5.14. Vermilion snapper: index of abundance (plus/minus two SE) from MRFSS data. Index from total catch (closed diamonds, solid line) is scaled to its mean, as is the index from harvest only (open squares, dotted line).

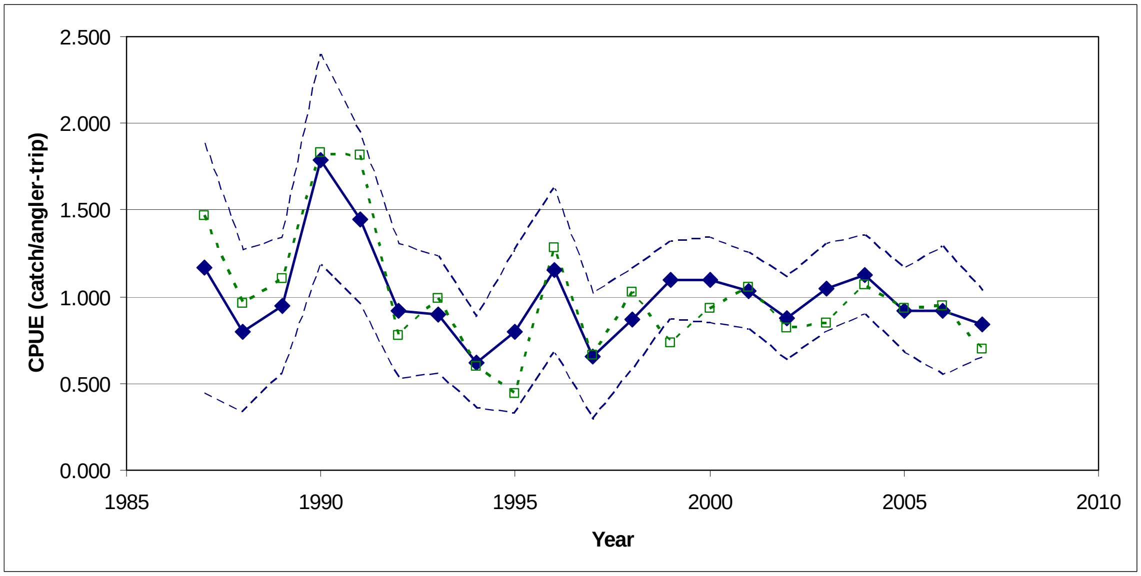
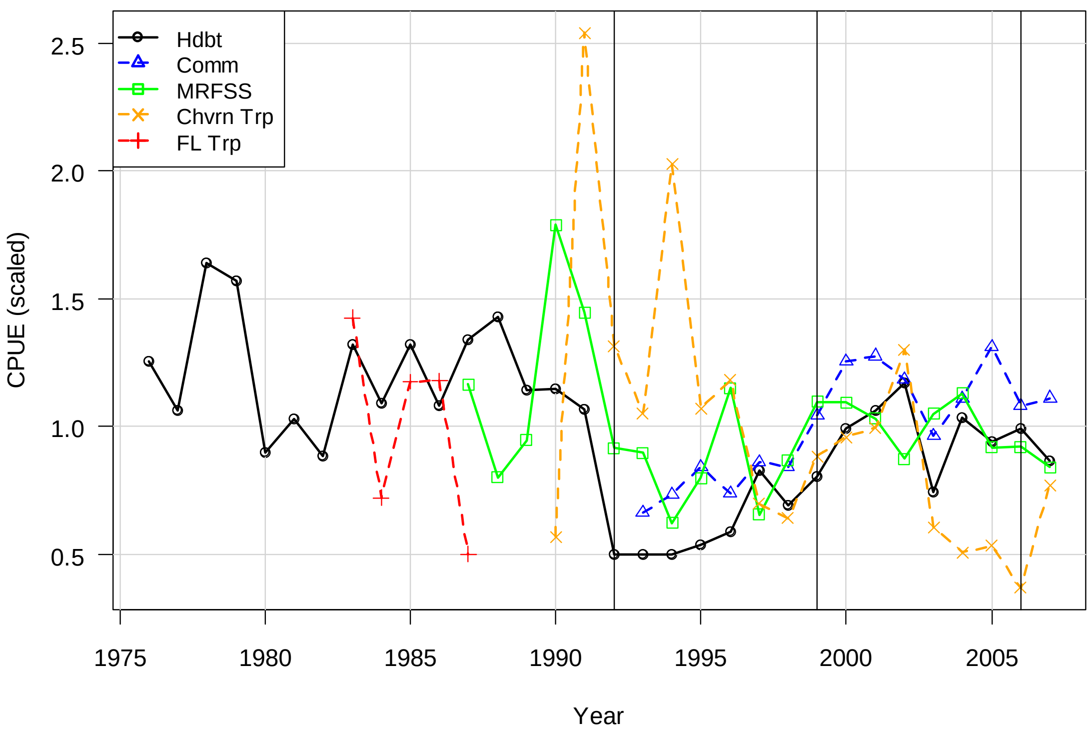


Figure 5.15. Vermilion snapper: indices of abundance recommended for use in the assessment. Vertical lines represent years with new recreational regulations. Each index is scaled to its mean.



5.10 APPENDICES

Appendix 5.1: Information contained in the commercial logbook data set (all variables are numeric unless otherwise noted):

schedule: this is a unique identifier for each fishing trip and is a character variable
species: a character variable to define the species
gear: a character variable, the gear type, multiple gear types may be used in a single trip, L = longline, H = handline, E = electric reels, B = bouy gear, GN = gill net, P = diver using power head gear, S = diver using spear gun, T = trap, TR = trolling
area: area fished, in the south Atlantic these codes have four digits- the first two are degrees of latitude and the second two are the degrees of longitude
conversion: conversion factor for calculating total pounds (totlbs) from gutted weight
gutted: gutted weight of catch for a particular species, trip, gear, and area
whole: whole weight of catch for a particular species, trip, gear, and area
totlbs: a derived variable that sums the gutted (with conversion factor) and whole weights, this is the total weight in pounds of the catch for a particular species, trip, gear, and area
length: length of longline (in miles) or gill net (in yards)
mesh1 – mesh4: mesh size of traps or nets
numgear: the amount of a gear used, number of lines (handlines, electric reels), number of sets (longlines), number of divers, number of traps, number of gill nets
fished: hours fished on a trip, this is problematic for longline data as discussed later
effort: like numgear, the data contained in this field depends upon gear type; number of hooks/line for handlines, electric reels, and trolling; number of hooks per longline for longlines; number of traps pulled for traps; depth of the net for gill nets, this field is blank for divers
source: a character variable, this identifies the database that the record was extracted from, sg = snapper grouper, grf = gulf reef fish, all records should have this source code
tif_no: a character variable, trip identifier, not all records will have a tif_no
vesid: a character variable, a unique identifier for each vessel
started: numeric (mmddyy8) variable, date the trip started
landed: numeric (mmddyy8) variable, date the vessel returned to port
unload: numeric (mmddyy8) variable, date the catch was unloaded
received: numeric (mmddyy8) variable, date the logbook form was received from the fisherman
opened: numeric (mmddyy8) variable, date the logbook form was opened and given a schedule number
away: number of days at sea, this value should equal (landed-started+1)
crew: number of crew members, including the captain

dealer: character variable, identifier for the dealer who bought the catch, in some cases there may be multiple dealers for a trip
state: character variable, the state in which the catch was sold
county: character variable, the county in which the catch was sold
area1 – area3: areas fished, if the trip included catch from multiple areas, those areas will be listed here
trip_ticke: character variable, trip ticket number, a unique identifier for each trip not all trips have this identifier

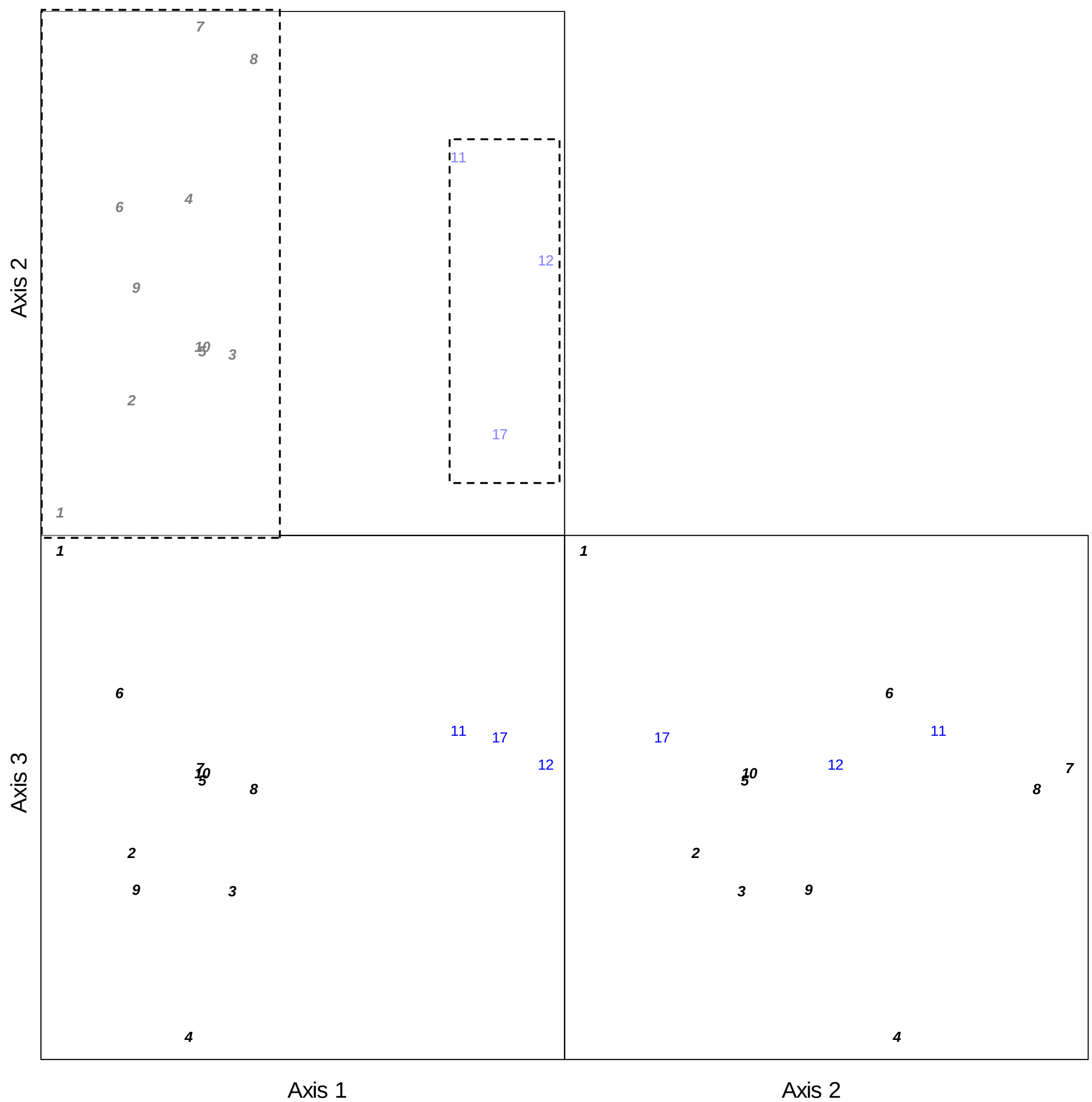
Appendix 5.2. Geographic areas with similarity in species landed.

This appendix describes multivariate statistical analyses used to identify geographic areas with similarity in species landed. Two techniques were applied—ordination and cluster analysis. Both require use of a measure of dissimilarity (distance) among areas. These analyses used the Sørenson (also called Bray-Curtis) measure of distance, a common measure in ecological studies (McCune and Grace, 2002).

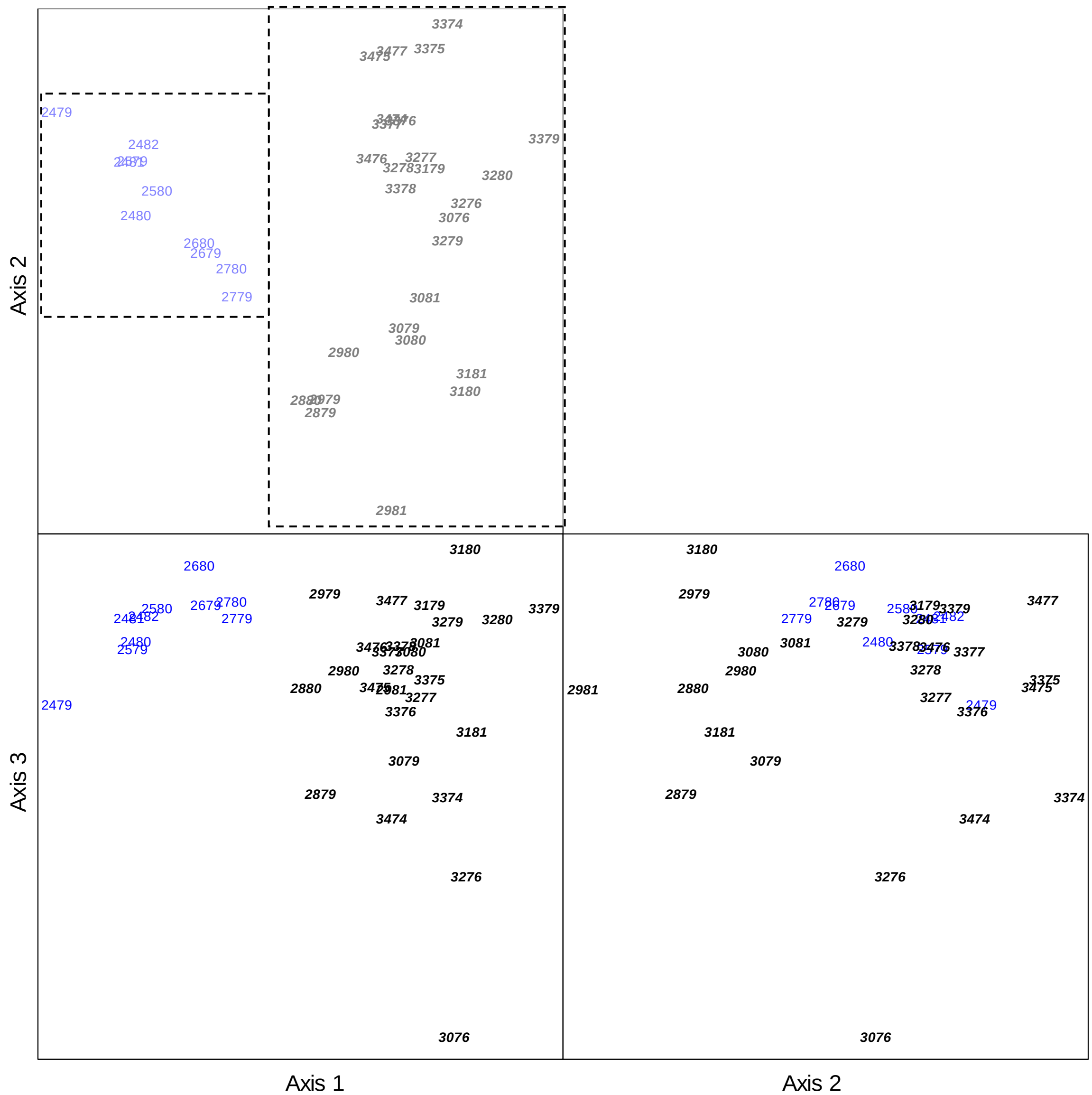
To compute dissimilarities, each data set (commercial logbook and headboat) was formatted as a matrix with rows representing geographic areas and columns representing species. Each element of the matrix quantified the relative frequency of species landed by geographic area. Thus, rows of the matrix summed to one. Geographic areas with a trivial number of records (<0.01%) were removed from the analysis, which left 292,316 records of area-species in the recreational (headboat) data set and 239,991 in the commercial data set. The resulting frequencies were then transformed using the arcsine squareroot transformation, as is appropriate for proportion data (McCune and Grace, 2002). After transformation, a matrix of dissimilarities between areas was computed using the Sørenson measure of distance.

To quantify similarity of areas based on their catch compositions, the ordination method of nonmetric multidimensional scaling (NMDS) was applied to the matrix of dissimilarities (Kruskal, 1964). In addition to ordination, nonhierarchical cluster analysis was applied in order to partition the geographic areas. This cluster analysis used the method of *k*-medoids, a more robust version of the classical method of *k*-means (Kaufman and Rousseeuw, 1990). As with any nonhierarchical method, the number of clusters *k* must be specified *a priori*. This study applied a range of values and selected the *k* most concordant with the data, as indicated by highest average silhouette width (Rousseeuw, 1987). In both commercial logbook and headboat data sets, optimal $k = 2$, with division between areas near Cape Canaveral, FL (Appendix 5.2A,B).

Appendix 5.2 Figure A. Nonmetric multidimensional scaling of areas from the headboat data. Rectangles in top left panel encapsulate areas with similar composition of landings, as identified by *k*-medoid cluster analysis. Areas north of Cape Canaveral, FL are in bold, black font.

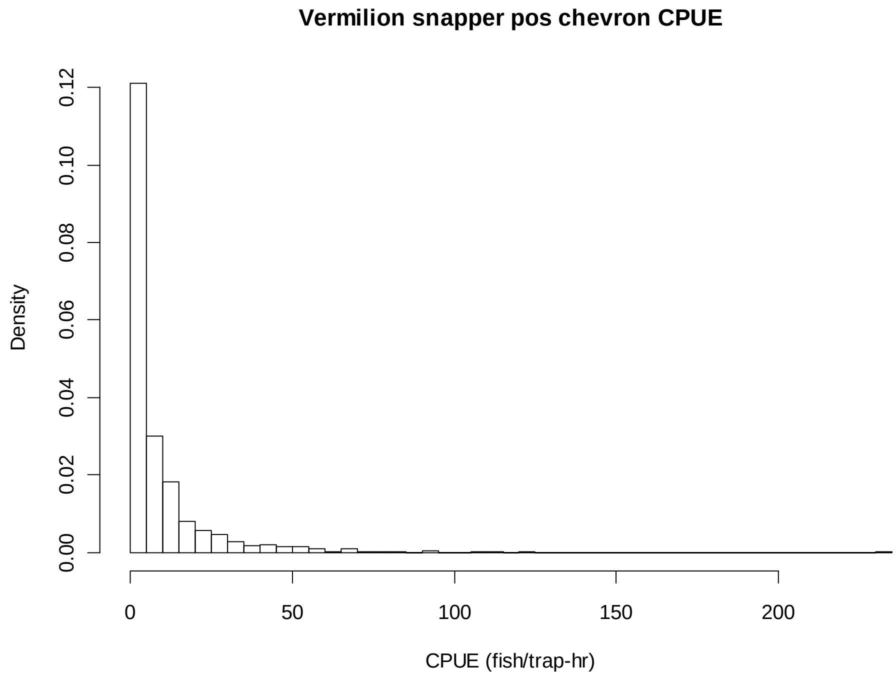


Appendix 5.2 Figure B. Nonmetric multidimensional scaling of areas from the commercial logbook data (handline). Rectangles in top left panel encapsulate areas with similar composition of landings, as identified by cluster analysis. Areas north of Cape Canaveral, FL are in bold, black font.

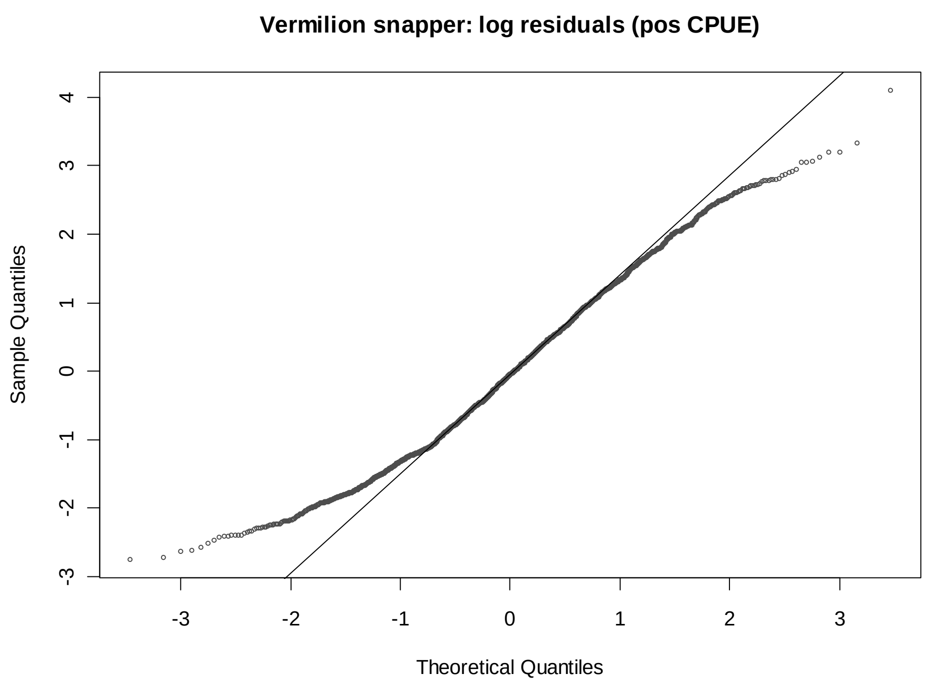


Appendix 5.3. Vermilion snapper: diagnostics of delta-GLM fitted to MARMAP chevron trap data.

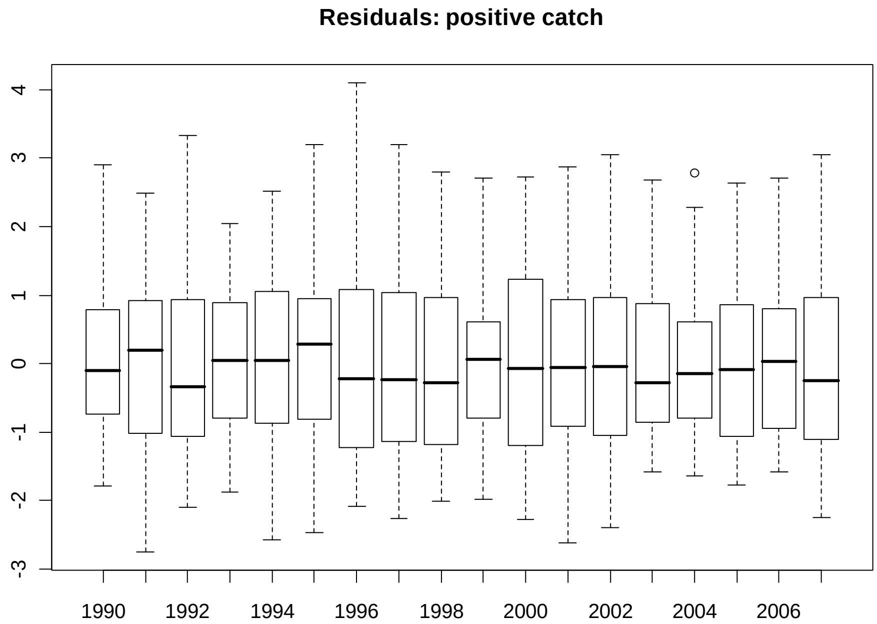
Appendix 5.3 Figure A.



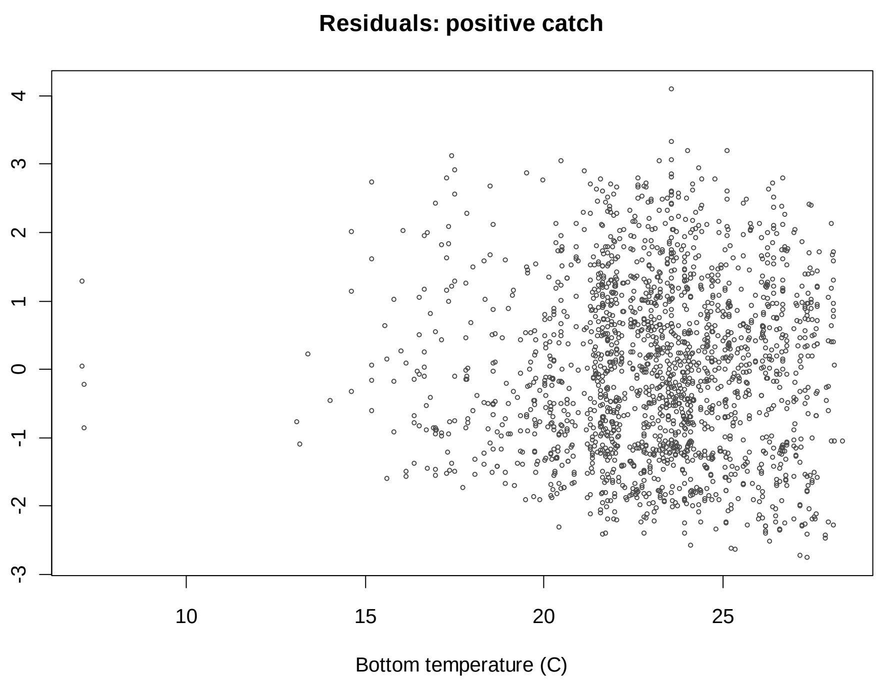
Appendix 5.3 Figure B.



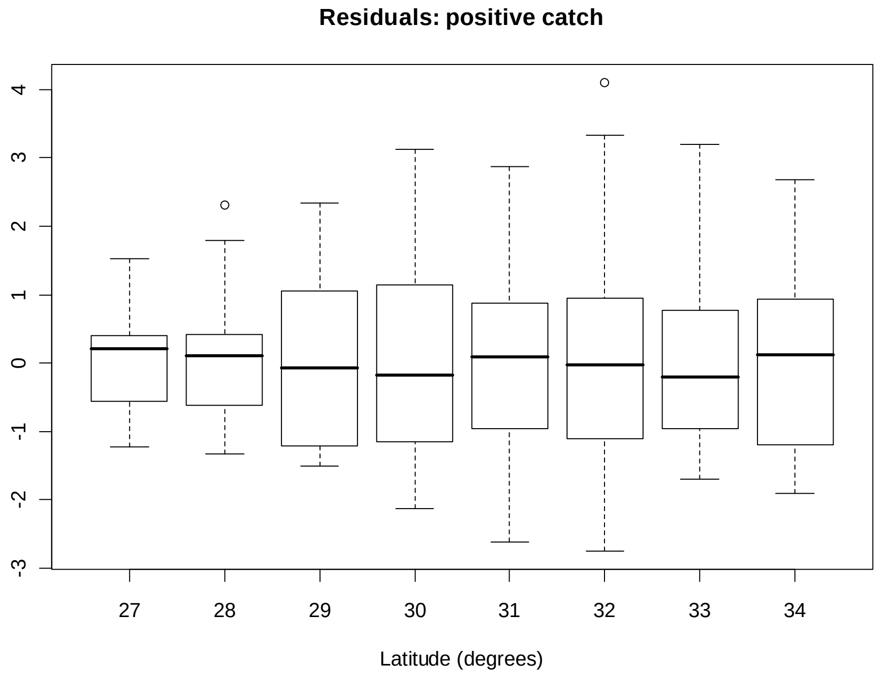
Appendix 5.3 Figure C.



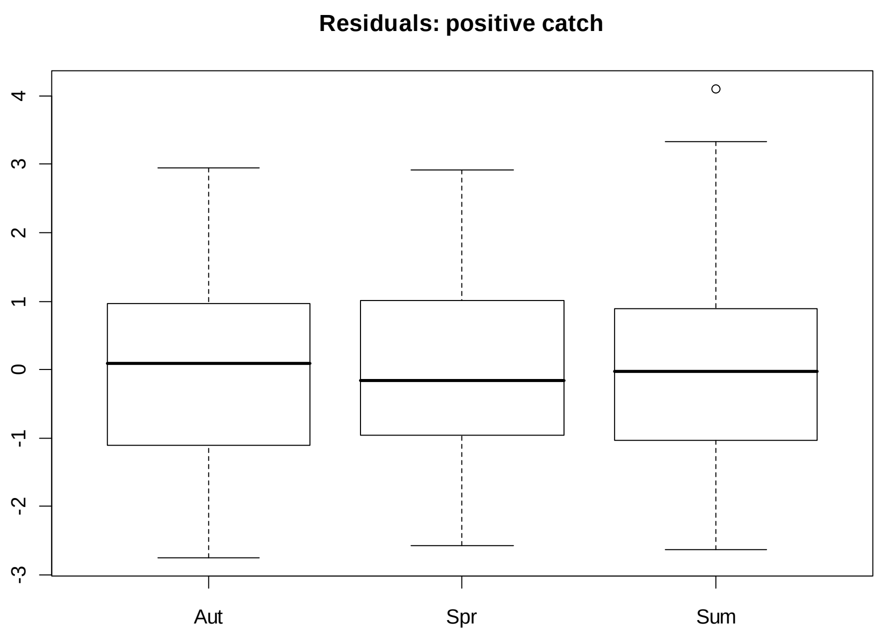
Appendix 5.3 Figure D.



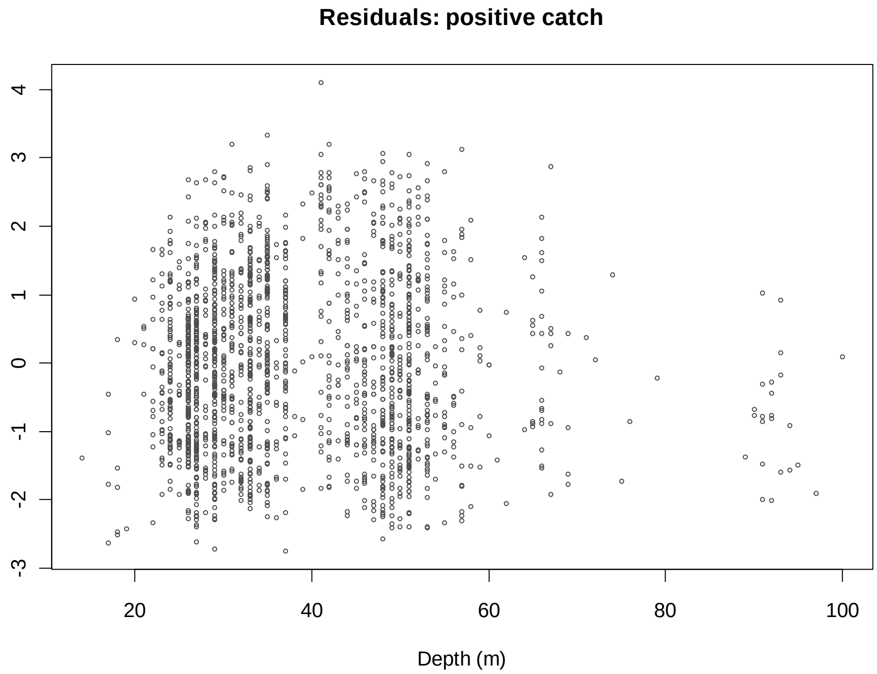
Appendix 5.3 Figure E.



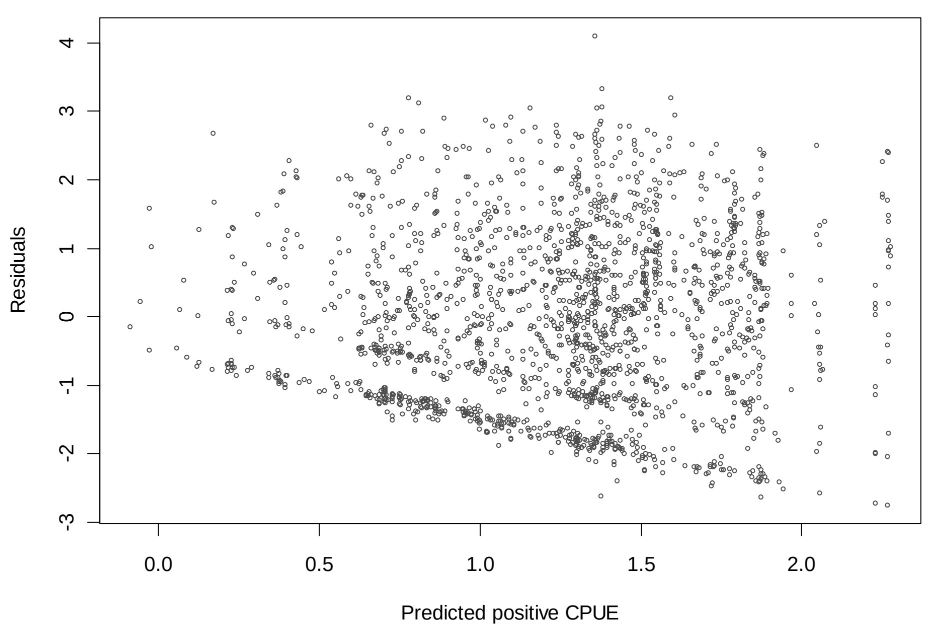
Appendix 5.3 Figure F.



Appendix 5.3 Figure G.

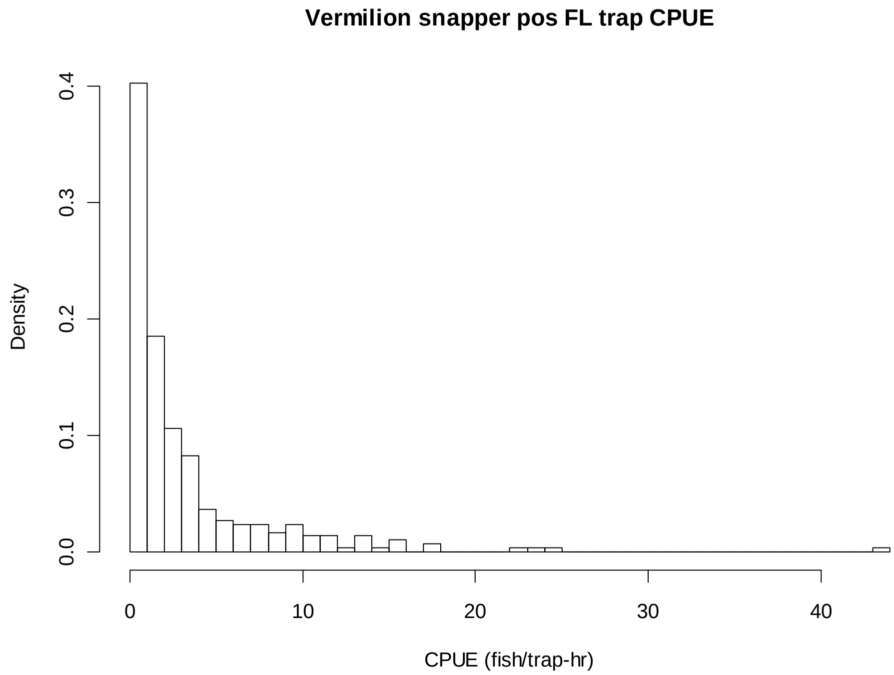


Appendix 5.3 Figure H.

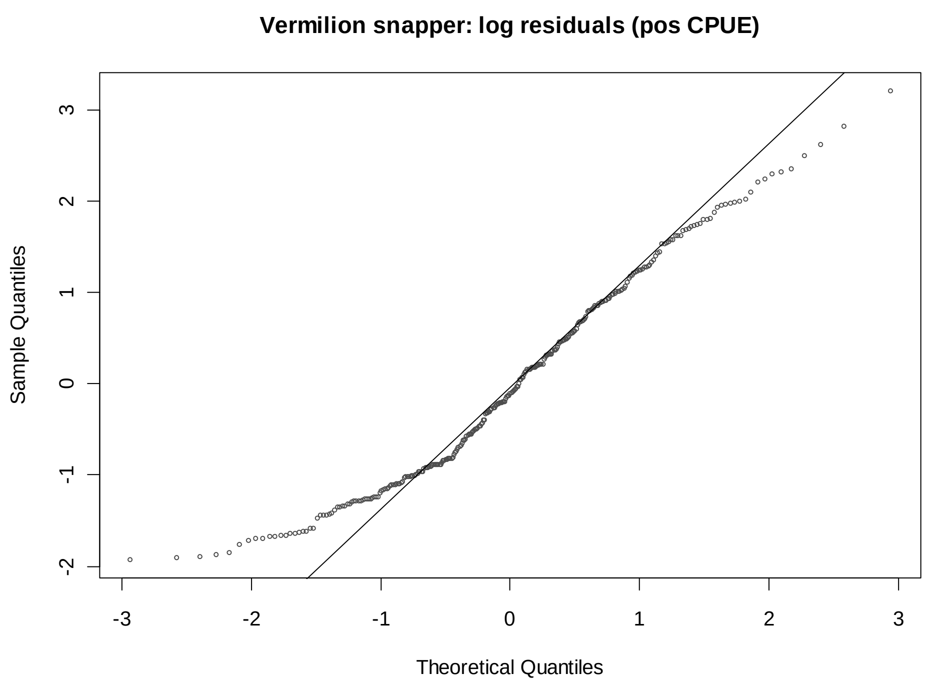


Appendix 5.4. Vermilion snapper: diagnostics of delta-GLM fitted to MARMAP Florida snapper trap data.

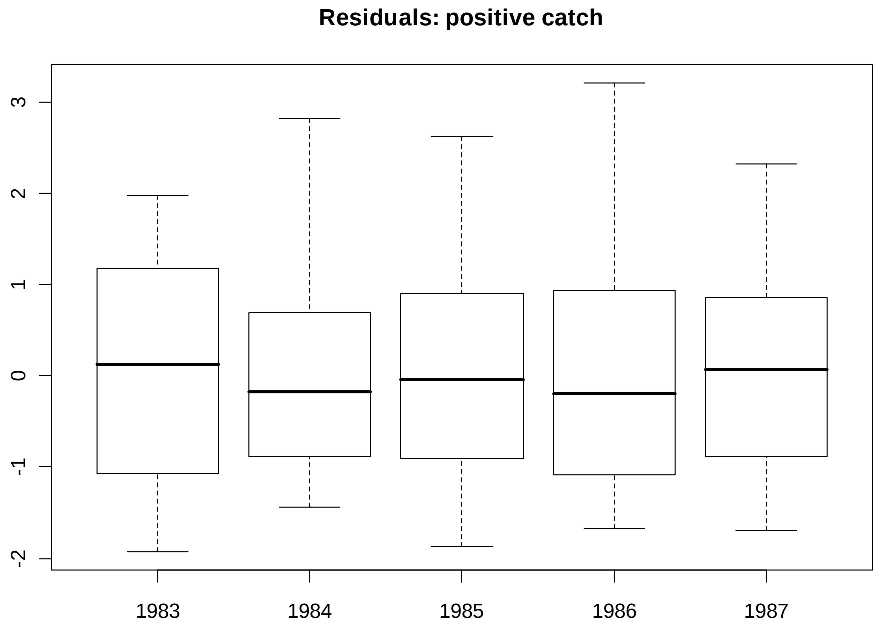
Appendix 5.4 Figure A.



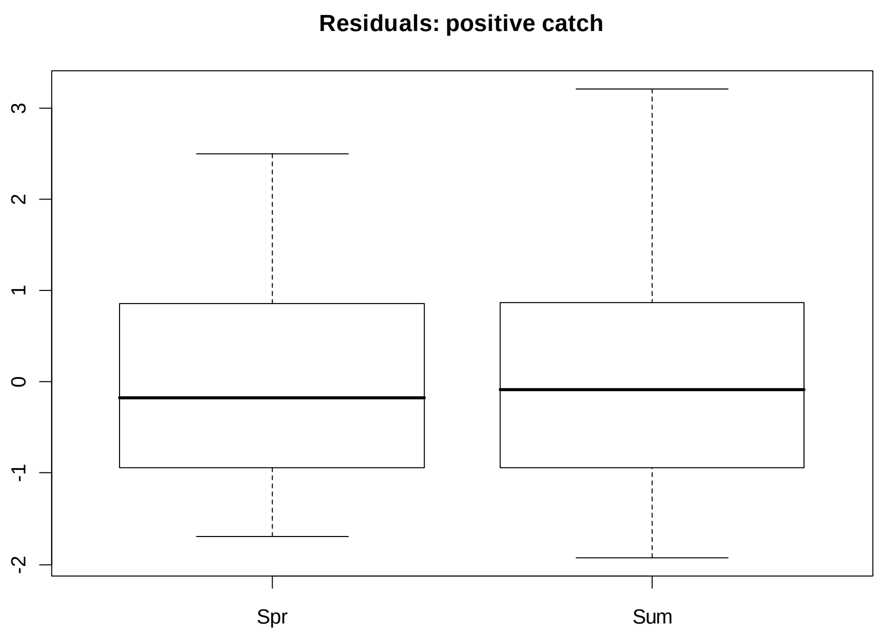
Appendix 5.4 Figure B.



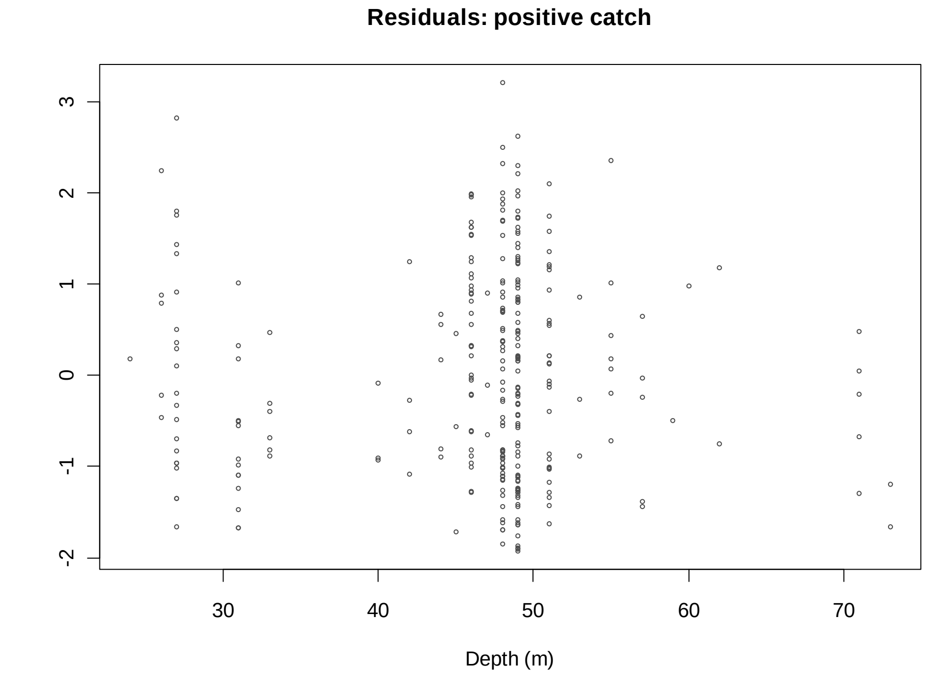
Appendix 5.4 Figure C.



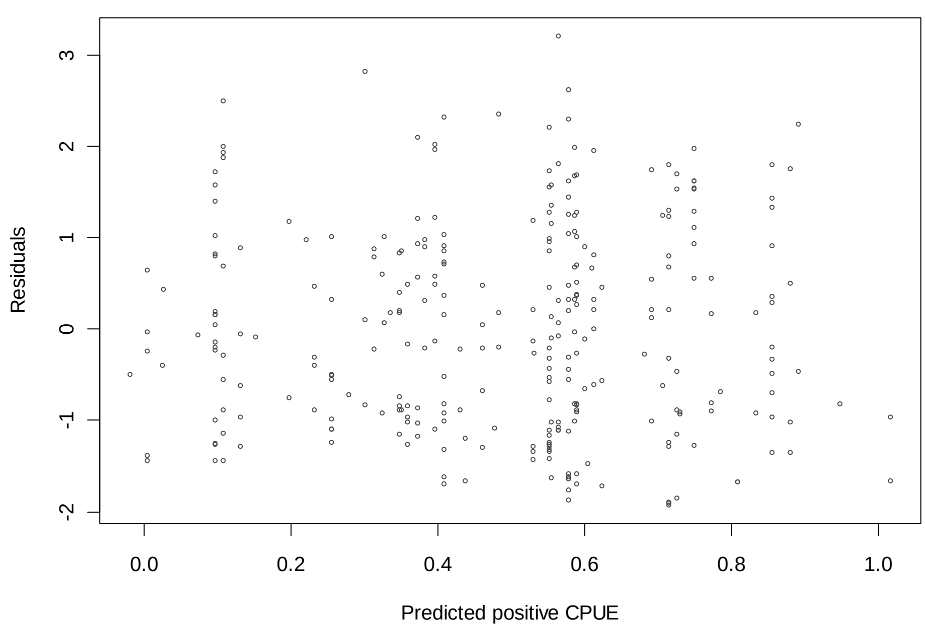
Appendix 5.4 Figure D.



Appendix 5.4 Figure E.

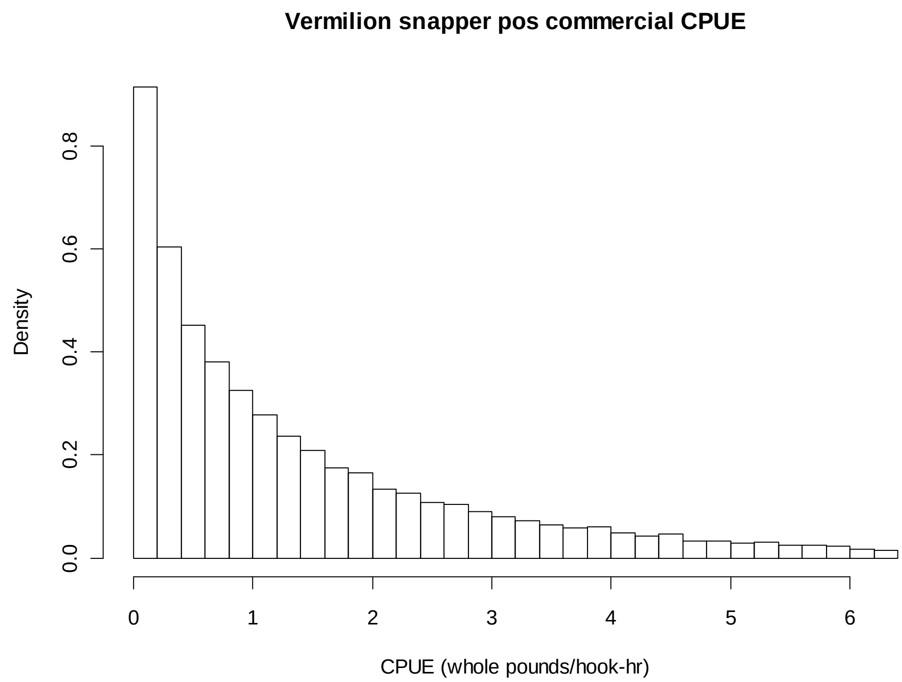


Appendix 5.4 Figure F.

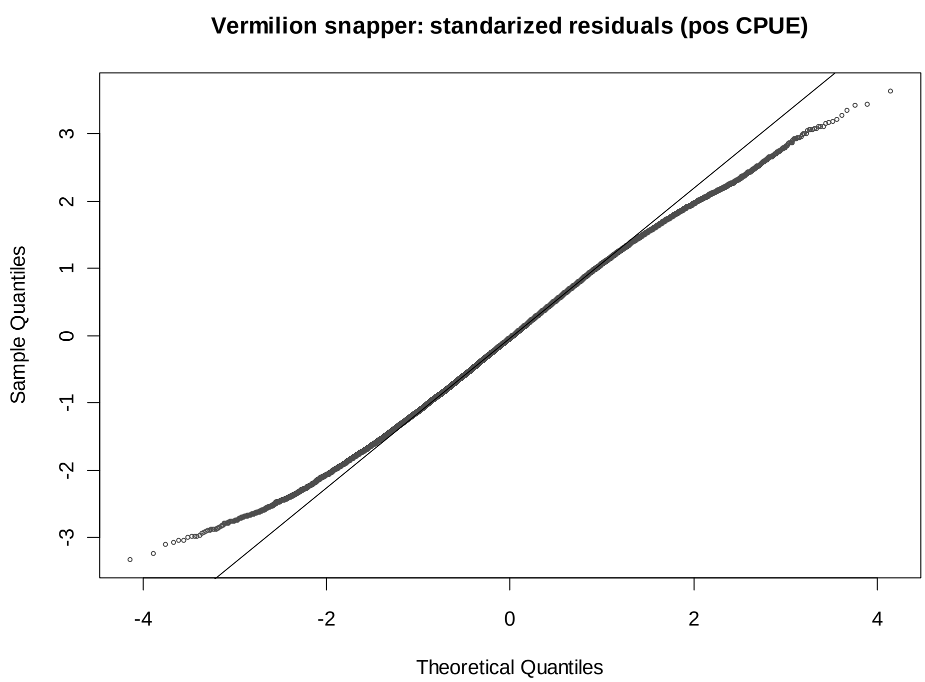


Appendix 5.5. Vermilion snapper: diagnostics of delta-GLM fitted to commercial logbook data. Gamma model residuals were standardized using method of Dunn and Smyth (1996).

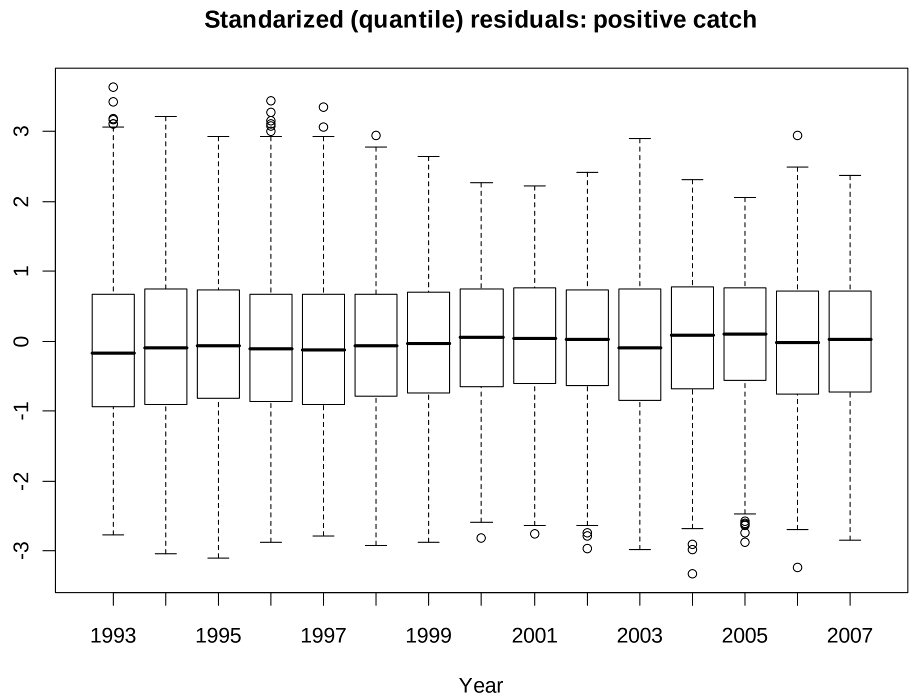
Appendix 5.5 Figure A.



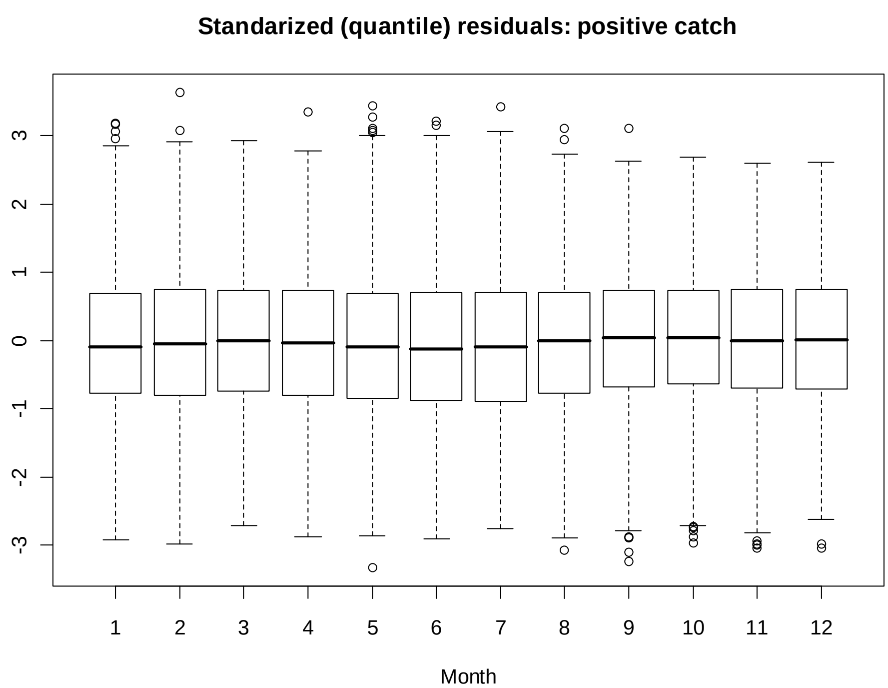
Appendix 5.5 Figure B.



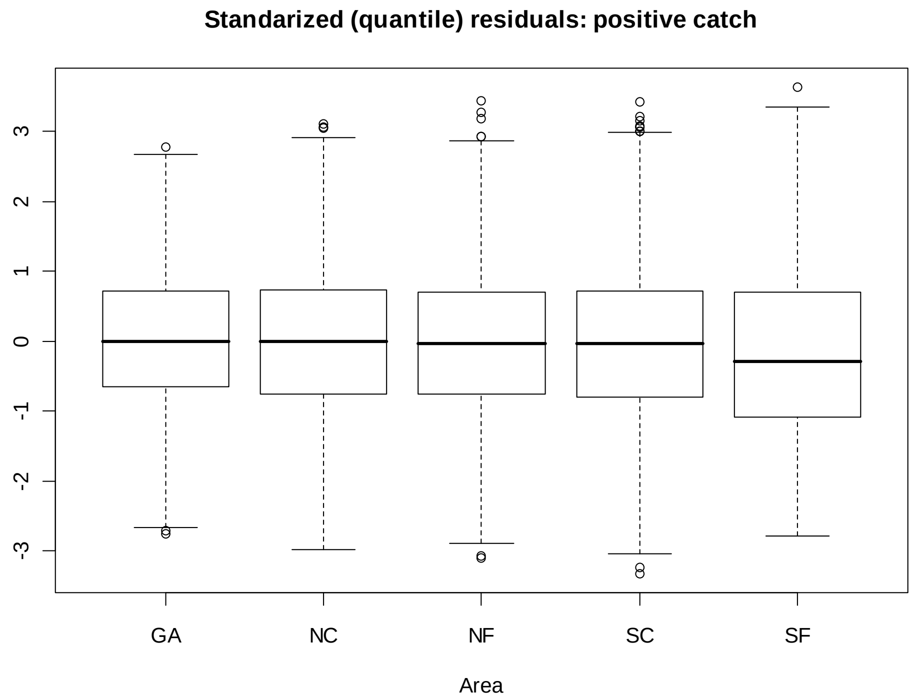
Appendix 5.5 Figure C.



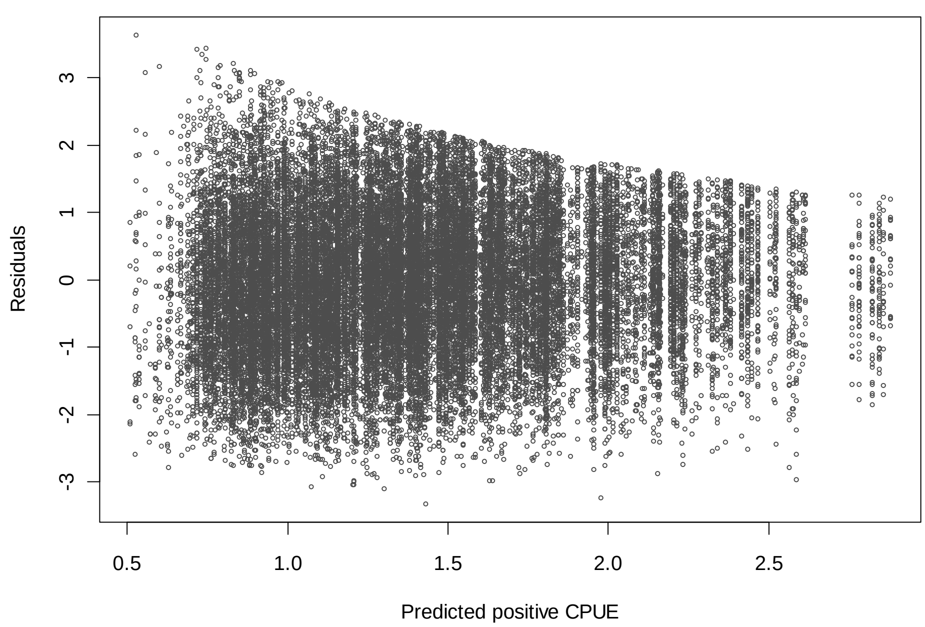
Appendix 5.5 Figure D.



Appendix 5.5 Figure E.

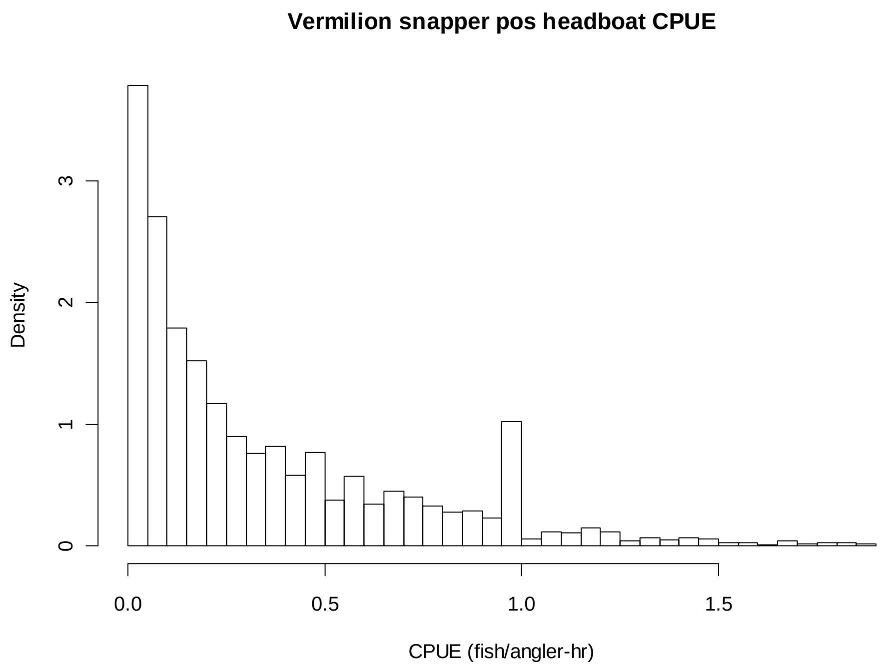


Appendix 5.5 Figure F.



Appendix 5.6. Vermilion snapper: diagnostics of delta-GLM fitted to headboat data. Gamma model residuals were standardized using method of Dunn and Smyth (1996).

Appendix 5.6 Figure A.



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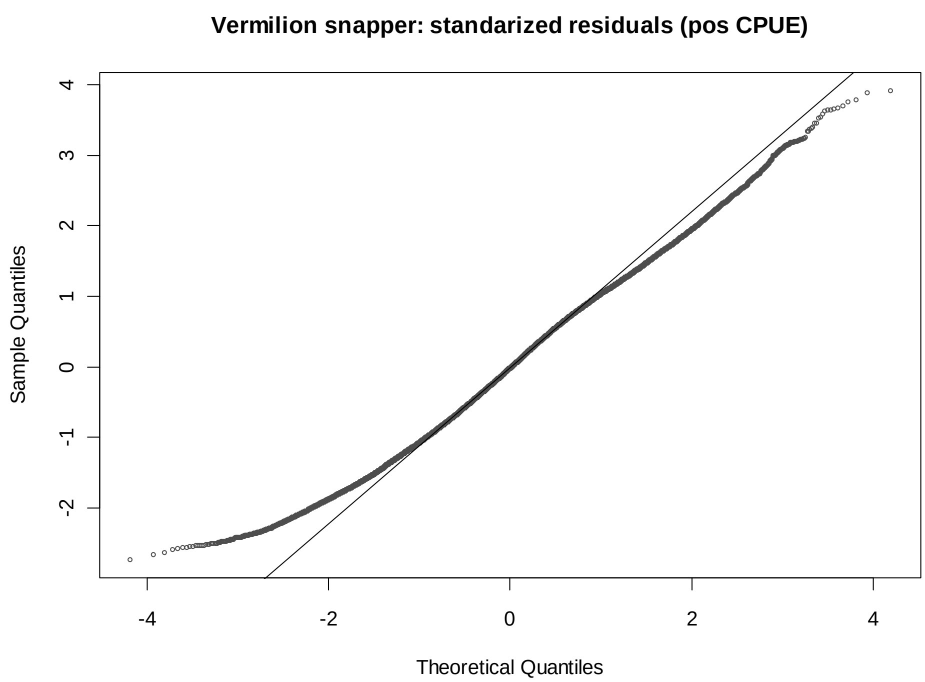
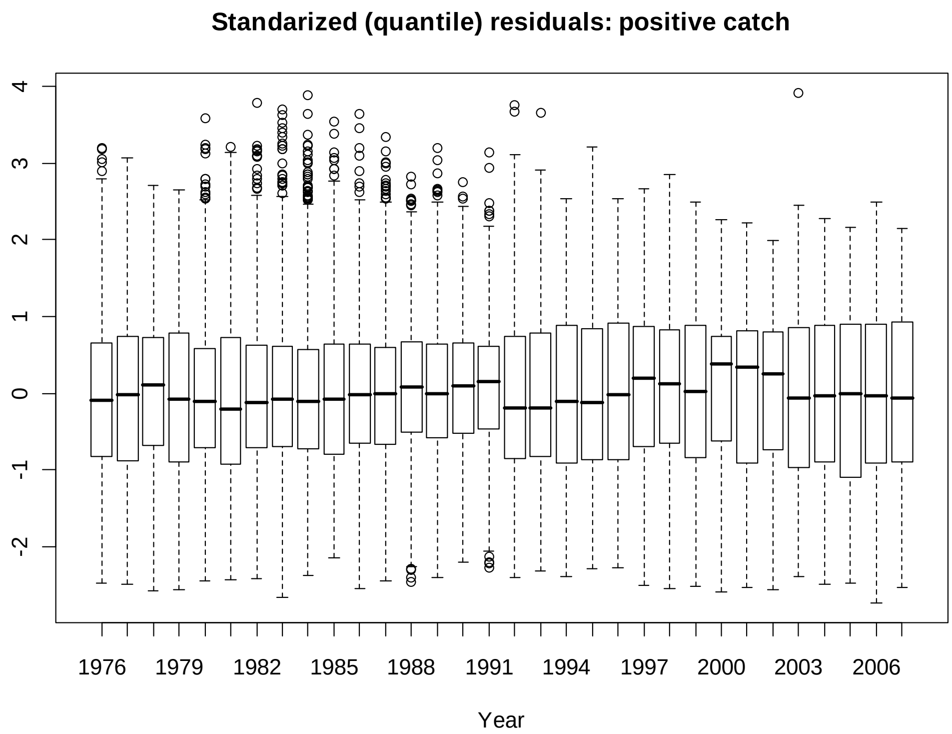
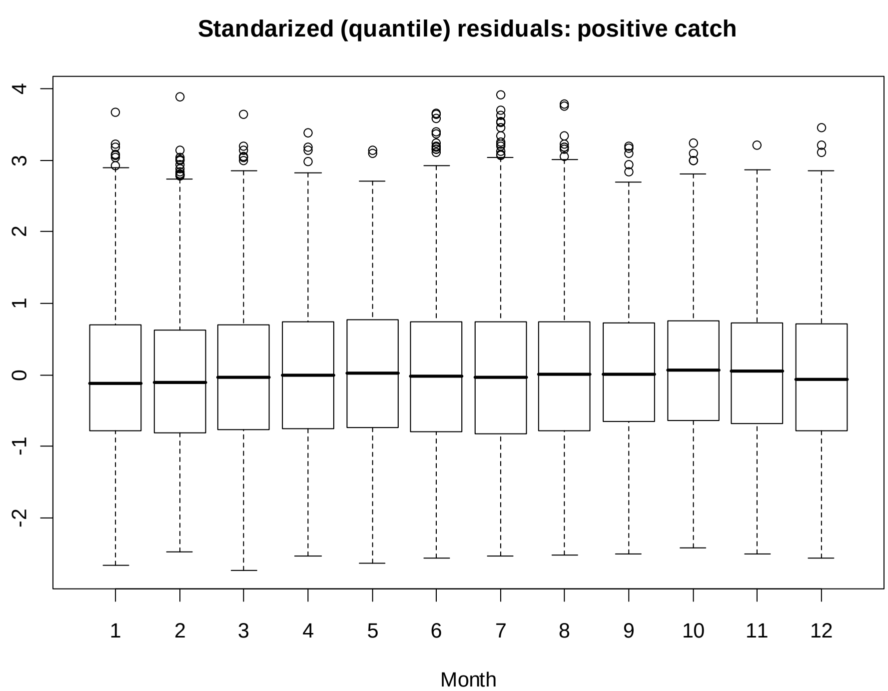


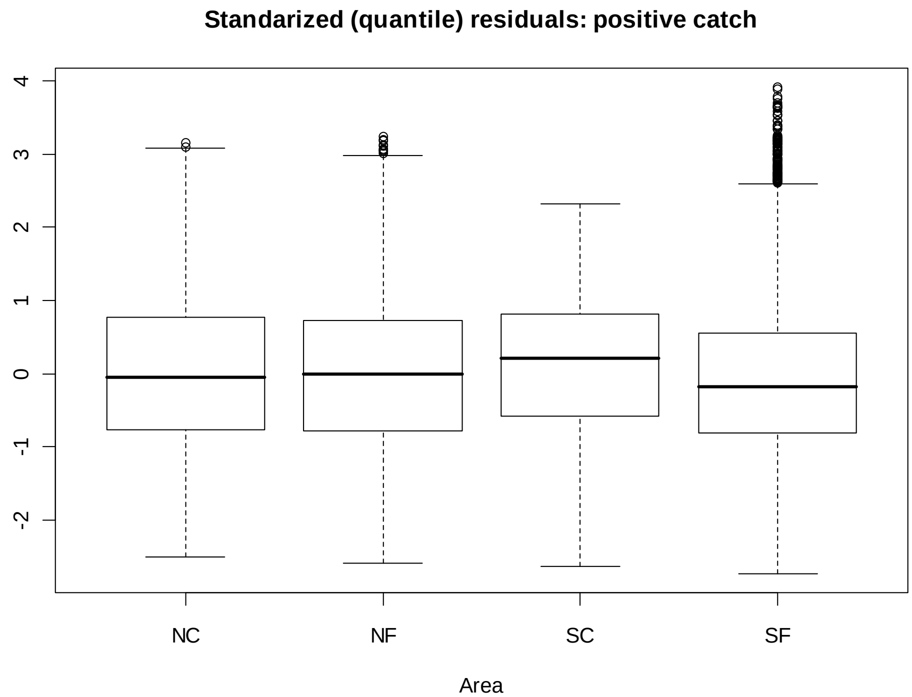
Appendix 5.6 Figure C.



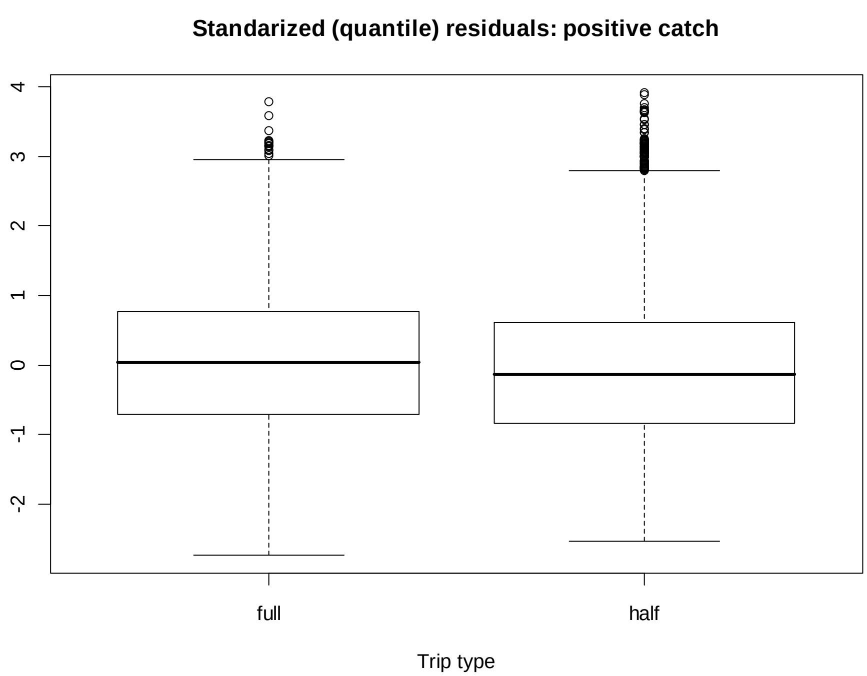
Appendix 5.6 Figure D.



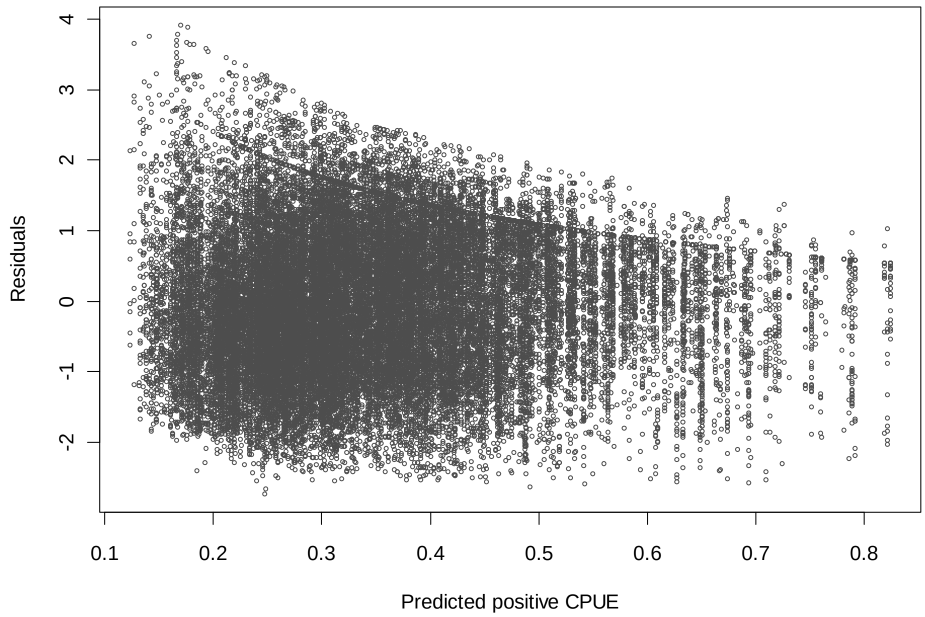
Appendix 5.6 Figure E.



Appendix 5.6 Figure F.

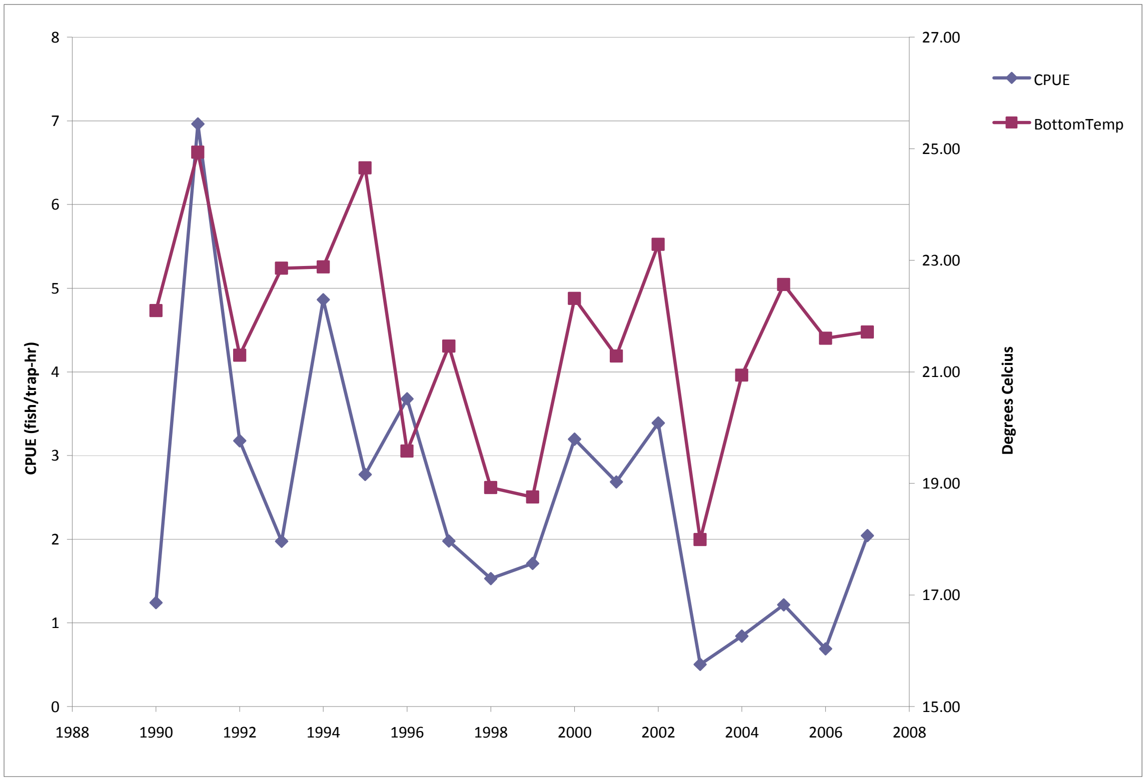


Appendix 5.6 Figure G.



Appendix 5.7. MARMAP chevron trap nominal CPUE and bottom temperature (Pearson $\rho = 0.55$; p-value = 0.02 from a *t*-test of H_0: $\rho = 0$).

Appendix 5.7 Figure A.



6. Submitted Comments